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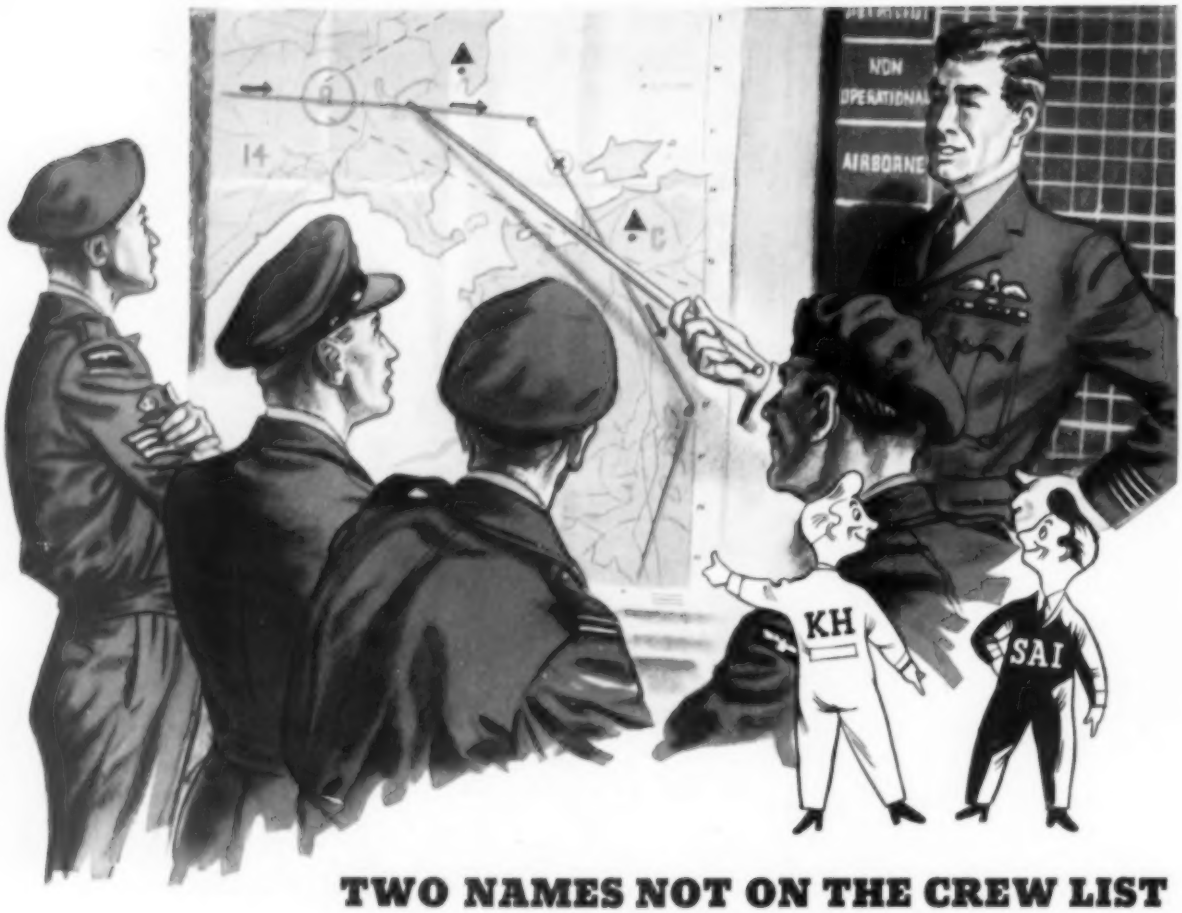

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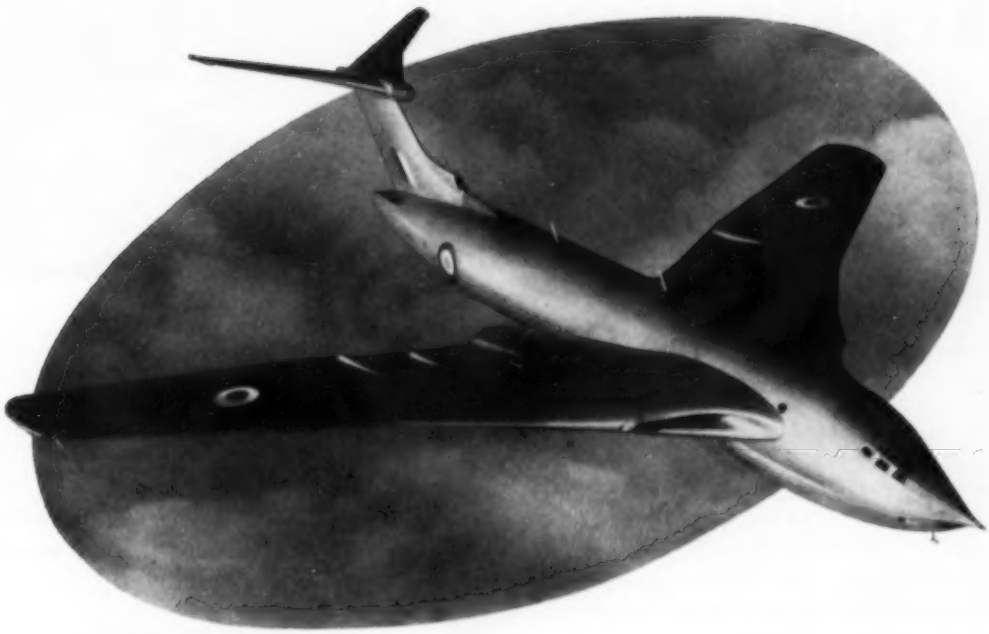

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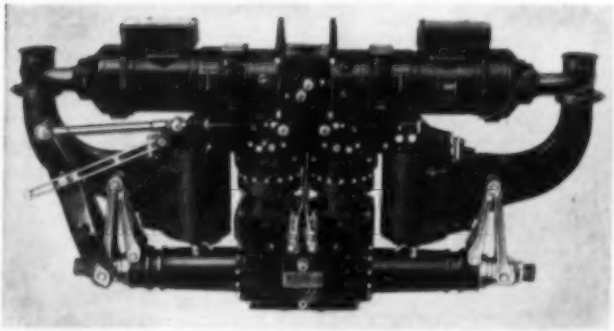

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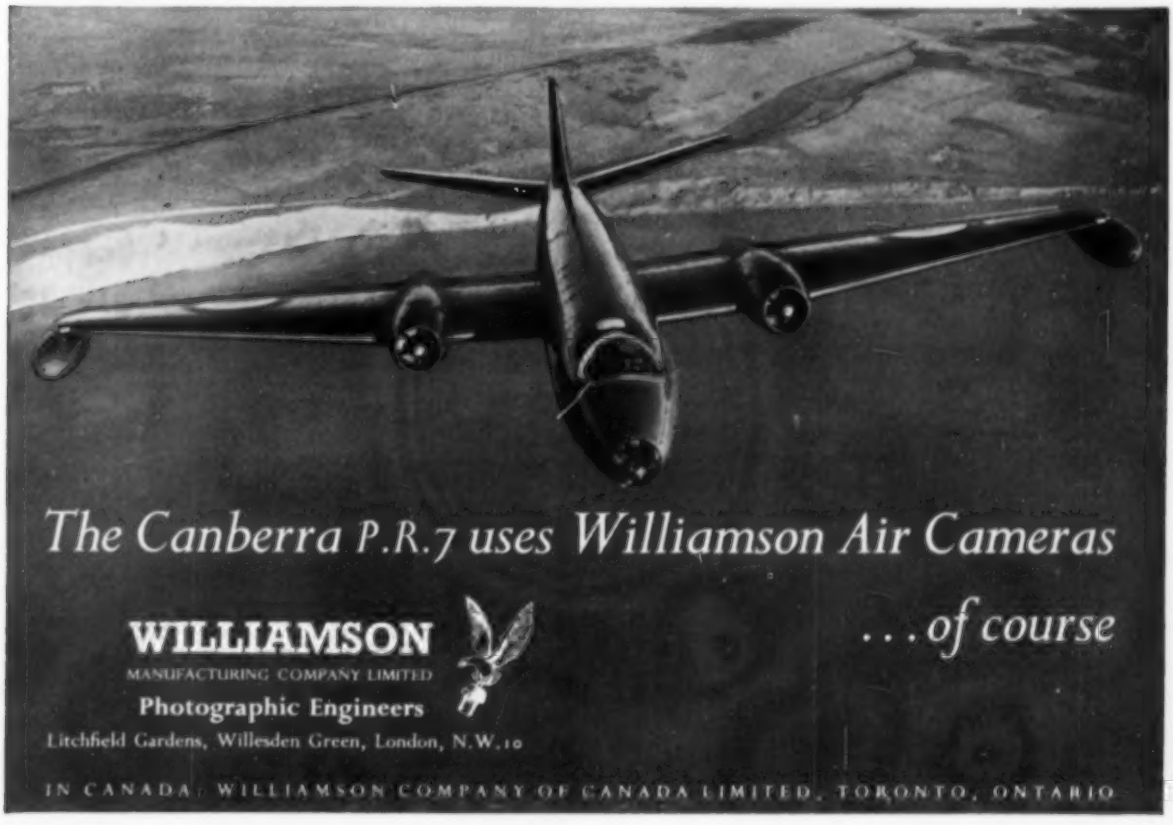

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Ready, Steady

OF the many large-scale exercises arranged by the R.A.F.—usually in co-operation with American and Allied European Forces—"Beware," which ended last weekend, proved the most encouraging. It was a home-defence exercise, intended to show how we might fare in the event of an all-out bomber attack on the British Isles. For the first time, there was no necessity to gloss over any terrifying gaps in our system of air defence.

It does not seem so long in retrospect (though it felt intolerably long during the waiting period) since we had to simulate jet bombers in such exercises. Next, for a while, the Canberras had to operate at restricted heights and speeds to give the fighters a chance. These are now subterfuges of the past, and although observers at bomber stations were not on this occasion permitted to know how the Canberras operated, there is no reason to suppose they were restricted in any way at all.

A very large number of Canberras made up the attacking forces, together with B-47s, B-45s, F-86s, F-84s, Mystères, Mistrals, Vampires and Meteors of the U.S.A.F. and French, Belgian and Dutch Air Forces. These proved to be sitting ducks for Hunters which managed to get among them, and reports indicate that the interceptions were numerous and what is even more important, were made well out to sea from the English coastline and, in some cases, higher than ever before.

The Hunters are one of two factors which have swung this defence exercise markedly in favour of the fighters. We sense that the squadrons operating them have been agreeably surprised at the speed with which they get away and climb towards their quarry, notwithstanding their heavy armament—in fact, with the way they have behaved all round in this, their first real exercise.

The second main factor has been the enormously improved radar service, both for early warning and vectoring. All who have seen something of it at home and on the Continent have been greatly impressed. Here again, the Hunter pilots were gratified to find that ground control really knew what was approaching in the way of enemy aircraft and where they were in the sky.

Night Starvation

Are there still any shortcomings in our air defence organization? The answer is yes: we badly need night fighters. Two Javelins got into the Beware act and apparently acquitted themselves admirably, each managing a number of interceptions. Now we need Javelins by the score, and all that has to go with them to enable them to operate efficiently. The Hunters alone cannot cope in all circumstances, because their pilots must see to shoot. In other words, they are (for the present at least) clear-vision aircraft only.

Should the question come to mind, we would give it as our opinion that the strength and performance of the Russian jet bomber force today is less than that of the force pitted against the home defences in this exercise. Sir Dermot Boyle, C-in-C. Fighters, confirmed this opinion, and he said also that if he were the enemy, he would be twice as reluctant to attack us today as he would have been six months ago. Bombers still, of course, get through, but not in anything like the numbers that they have done previously; and this time they were free to use every trick the planning staffs could think of. The ambiguous remark of the opposing commands was that the exercise was very satisfactory from both fighters' and bombers' points of view.

Two cheering notes round off our thoughts on this latest, largest-but-one defence exercise since the war. First, Beware is today a very appropriate name. It implies readiness without tension. As a nation, together with our Allies, we are still unable to relax our military preparedness, but equality of strength, or the fact that we are now joined in nuclear deadlock, seems to be leading toward happier relationships between East and West. Secondly, in all the 7,500 sorties flown by the new Hunters and other defending aircraft, not one pilot lost his life in an accident.

ROUGH PASSAGE was experienced by the new £10 million carrier H.M.S. "Hermes" while being towed from Liverpool to Barrow-in-Furness. Eventually she was towed in to Belfast (as seen) with a dented hull and a damaged propeller.

FROM ALL QUARTERS

Whitney Straight for Rolls-Royce

IT is announced by Rolls-Royce, Ltd., that Mr. Whitney Straight will join the board of the company on November 1st. He will take over the duties of executive vice-chairman from Mr. A. G. Elliot on January 1st, 1956.

The following letter from Mr. Whitney Straight, present deputy chairman of B.O.A.C., was received by the Minister of Transport and Civil Aviation on October 3rd:—

"I am writing to ask if you would be good enough to release me from B.O.A.C. because I wish to accept an invitation to join the Rolls-Royce Co. on the 1st November, 1955. Sir Miles Thomas, whom I have of course consulted, is agreeable.

"For the last 22 years I have been on the flying side of the aviation industry. Of these years 16 have been devoted to public service in the Royal Air Force and the Airways Corporations. I have for some time wanted to broaden my experience and the invitation from Rolls-Royce provides an exceptional opportunity. I feel very happy and fortunate to have been asked to join the finest team I know on the manufacturing side.

"To leave so many old friends in both Corporations has been a difficult decision to take as we have had such a pleasant and constructive association for so many years. But I am conscious of leaving at a time when the future has never looked more promising. I will miss also the very close relationship that I have enjoyed with the prominent officials of your Ministry. Thank you for having the time despite the tremendous burdens of your responsibility to be so personally kind and interested."

Mr. Boyd-Carpenter replied:

"I am sorry indeed to hear that you wish to leave B.O.A.C. at the end of this year. It is not easy to imagine British civil air transport without you who have devoted so wholeheartedly and enthusiastically your energies and great experience of aviation to both Air Corporations in turn during the ten formative years after the war.

"The work you put in first as deputy chairman of B.E.A. and then on B.O.A.C.'s board and in particular the work you have done as B.O.A.C.'s deputy chairman in the last six years is now reflected in the high esteem in which both Corporations are held all over the world. You have helped to set the tremendously high standard.

"I am glad that you are going to continue on work which is no less vital to British aviation and indeed to the future of this country. I know that you have a great deal to contribute to the world-famous enterprise which you are joining. May I wish you all success in your new and important work and take this opportunity of thanking you most sincerely for all you have done in your eventful and strenuous years of public service with the Air Corporations."

Mr. A. G. Elliot.

Mr. Whitney Straight

Mr. Elliot Retires

WITH the retirement of Mr. A. G. Elliot, referred to in the foregoing paragraph, the industry loses one of its most talented, and most respected, engineers.

Mr. Elliot retires at the age of 66. He was born on November 3rd, 1889, and was educated at Northampton College and London University. He joined Napiers in 1909 and Rolls-Royce in 1912, and in his first year was attached to Mr. F. H. Royce's personal design staff. He was senior designer on the Rolls-Royce Eagle, Hawk, Falcon, Condor and Kestrel aero engines and in 1929 was appointed chief designer, being responsible for both aero and car engines. Under Sir Henry Royce he was personally responsible for the design of the Rolls-Royce R engine, which in a Vickers-Supermarine seaplane, was the means of winning the Schneider Trophy outright. Mr. Elliot was also in charge of the design of the Merlin.

In 1937 he was made chief engineer of the aero division, later becoming chief engineer of the company. He was made a director of Rolls-Royce, Ltd., in 1945 and became joint managing director in 1951.

His awards include the C.B.E. (1941) in recognition of his work on aero engines and the British Gold Medal for aeronautics (1954). Mr. Elliot was appointed executive vice-chairman in 1954. He is a member of the Air Registration Board, a Governor of Loughborough College, a council member of the Royal Aeronautical Society and a member of technical board and technical department for S.B.A.C.

V.1000 Speculation

THE future of the Vickers 1000 jet transport was the subject of renewed speculation on Monday, when a newspaper reported that the R.A.F. had told the Ministry of Supply that it did not want the aircraft which it has on order. As recorded in *Flight* of September 16th, the Ministry of Supply recently confirmed that the future of the V.1000 in both military and civil forms was "under consideration in the light of the probable performance of the aircraft and the general transport aircraft situation here and overseas." One prototype is at present being built to Ministry of Supply contract at Wisley and a number of production aircraft (a figure of six has been reported) have been ordered for the R.A.F., though it is believed that construction has not yet begun.

At the time of writing, the makers of the aircraft had no knowledge of any decision to cancel the R.A.F. order. Though the newspaper report suggests that "disappointing" performance estimates are responsible for the present second thoughts on the V.1000, it is believed that the question at issue is one of policy and that, on paper, the project is no less promising than in its original form. The Government may consider that, in view of recent American developments in the field of large jet transports, the potential market for a developed civil version of the V.1000 has been considerably reduced. The R.A.F., for its part, is presumably considering the use of Britannias in preference to the larger and faster, but considerably more expensive, jet transport.

Turin Turbojet

THE first gas turbine entirely designed and manufactured in Italy, the Type 4002 turbojet, has just been announced by the Fiat company. It is an essentially simple, and in some respects novel, unit with a current rating of 550 lb static thrust. In its design particular attention has been paid to reducing manufacturing cost, and a wide range of applications is foreseen.

At the front is a central intake surrounded by the integral oil tank and wheelcase to the auxiliaries. The single-sided compressor impeller is of a highly rated design, with pre-whirl, the mechanical design being such as to ease manufacture on either a short-run or mass-production basis. The annular combustion chamber is of the inverted-flow type, the compressor delivery passing back along the outer periphery, past multiple burners at the rear and

forwards through the flame tube space. (The assembly is like an "annularized" Rover system.) There are only two—easily removed—portions in this chamber, and performance on test is described as excellent. The turbine is a single-stage unit, with separate blades attached by fir-tree roots, mounted close up against the compressor.

Altogether the Fiat 4002 seems to be a practical and useful unit, and it is certainly efficient in mechanical design, has a good weight/thrust ratio and should be cheap and reliable when fully developed. Preliminary data include: Maximum static thrust, 550 lb at 26,000 r.p.m. with s.f.c. of 1.25 lb/hr/lb; dry weight, 219 lb; specific weight, 0.398.

The Whirlwinds Arrive

THE two Westland Whirlwinds which left Eastleigh Airport, Southampton, on September 20th to fly to Doha in the Persian Gulf arrived there on schedule on September 27th, after a trouble-free flight of over 3,300 miles, of which one leg entailed a sea crossing of 250 miles—between Rhodes (an island in the Mediterranean) and Nicosia, Cyprus. The flight is the longest ever made by a British-built helicopter and constitutes a new long-distance record for Britain with this type of aircraft.

The two Whirlwinds, which have been added to the aircraft fleet of the Royal Dutch Shell Group, are to be used to transport workmen and supplies from shore bases to oil-drilling rigs at sea. Provision has been made for the aircraft to carry flotation bags so that they can alight on the water if necessary. On the journey to the Persian Gulf the two Whirlwinds—which were accompanied by a Dakota carrying spares—were flown by Alan Bristow and Alan Green. The machines will be operated in the Gulf area on behalf of the Royal Dutch Shell Group by Bristow Helicopters, Ltd., Henstridge, Somerset, of which Mr. Bristow is managing director.

Norwegian High Command

THE appointment has been announced of Lt-Gen. Finn Lambrechts, C-in-C. Royal Norwegian Air Force, as Chief of the Norwegian Defence Staff. He succeeds Lt-Gen. Ole Berg, who has reached retirement age.

Lt-Gen. Lambrechts is 55. Before the First World War he served as a deck-boy in sailing vessels. Later he joined the Navy and eventually trained as a pilot in the Naval Air Arm. In 1928 he joined in the Arctic air search for Roald Amundsen and the Italian Nobile. Later he was appointed chief pilot to D.N.L. and in 1938 became Norway's first "air millionaire." During the late war he was piloting Catalinas over the North Atlantic, and he led some daring exploits over Norway.

Equipment for M.A.T.S.

THE future equipment requirements of the U.S. Military Air Transport Service were discussed by Major General E. Moore, Chief of Staff and Second-in-Command, M.A.T.S., in a talk at a recent meeting of Aviation Forum. After describing the origins and present establishment of M.A.T.S., General Moore outlined its need for two basic types of transport aircraft: one, a high-speed, pressurized, all-weather turbojet passenger and cargo transport capable of non-stop Atlantic operation with a 30,000 lb payload; and the other, a medium-sized turboprop freighter capable of lifting 50,000 lb payloads over medium and long ranges. These two basic types of transport would ideally satisfy the world-wide strategic requirements of M.A.T.S.

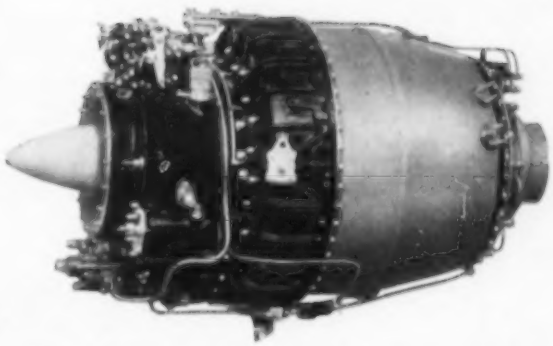
General Moore emphasized the strategic, as distinct from tactical, role of M.A.T.S. "Strategic air transport has to do with the broader aspects of a war. It is used for the deployment of Air Force strike units to overseas theatres. It is also employed to airlift personnel, cargo and combat forces of all services from the United States to all theatres of operations in support of a total war effort. Its return capacity is used for returning traffic, including aero-medical evacuation from the active theatre, to the United States." The General recalled that in the Korean conflict M.A.T.S. in three years lifted 230,000 personnel and 60,000 tons of freight from the U.S. to Japan, and returned 70,800 sick and wounded.

J40-Demon Inquiry

CHAIRMAN of the House of Representatives military operations sub-committee, Mr. C. Holifield, has ordered an inquiry into the purchase of early versions of McDonnell F3H Demon single-seat carrier-based fighters for the U.S. Navy. Mr. Holifield is quoted as saying "if there is a substantial question of faulty procurement by Navy officials, our sub-committee will want to pin down the responsibility."

In its original form the F3H was powered by the Westinghouse J40 turbojet (as were most other projected Navy fighters). As is now well known, this engine failed to develop into a usable and efficient powerplant, and great re-engining programmes were required, resulting in late delivery of many types of aircraft. In the event, later production F3Hs have the satisfactory, and much more powerful, Allison J71, but 56 Demons were delivered with the J40, at a cost of over £23m. It is reported that six F3H-1s crashed, with the loss of two pilots, owing to lack of power.

It is now learned that 29 F3H-1s will be re-engined with the J71, at a cost of £1,428,000. The remaining 21 will be used for armament research and ground training. The basic Demon is priced at £370,000, exclusive of powerplant and instruments. A J40 is quoted at £80,000 and a J71 at the remarkably low figure of £52,000. The much superior F3H-2, with J71 and a larger wing, is now coming into full service. This type recently underwent carrier trials (picture last week).



ITALY'S FIRST TURBOJET: Described in an adjacent news item, the Fiat Type 4002 turbojet is the first Italian-designed turbojet to materialize. It is now on view at the Turin Technical Exhibition.

Piasecki Name-change

THE Piasecki Helicopter Corporation, of Morton, Pennsylvania, is to change its name to the Vertiplane Corporation, and to increase the board from 11 to 13 members. The name-change has been made "to identify the firm more fully with the broad field of vertical flight, which includes, in addition to helicopters, V.T.O.L. (vertical take-off and landing) aircraft and convertiplanes." The board of directors is recommending that the shareholders elect Thomas K. Finletter, a former Secretary of the Air Force, to the board.

Guild Awards

AS announced in *Flight* for September 16th, the Cumberbatch Trophy for air safety and reliability was awarded by the Guild of Air Pilots and Navigators to Silver City Airways, Ltd., "in respect of their car ferry service, which has attained a very high reputation for reliability and excellence of service to the public." The Guild's other trophies for 1954 were awarded as follows:—

Brackley Memorial Trophy (for outstanding achievements concerning the operation of flying boats): R.A.F. Station Pembroke Dock, in recognition of the work done by Sunderlands of 201 and 230 Squadrons in maintaining the British North Greenland Expedition 1953/54.

Derry and Richards Memorial Medal (for the best achievement in experimental flying for the year by a civilian pilot): W/C. R. P. Beamont, D.S.O., O.B.E., D.F.C., for outstanding work in supersonic flight development and for his past development work in numerous types of aircraft, including Britain's first jet bomber.

No nominations were received for the Johnston Memorial Trophy which is awarded for the year's best feat of air navigation. As, in the Guild's view, no feats of air navigation of sufficient merit were discovered, it was decided not to award this trophy.

Presentation of the trophies will take place at the Guild's annual ceremonies later in the year.

Sherpas at Yeovil

TWO Sherpas—of the Himalayan, not the Belfast, variety—were among a party of members of the successful Kangchenjunga Expedition who visited Yeovil last week to give a lecture to the Yeovil Branch of the Royal Aeronautical Society.

The lecture, the first to be given since the team returned, was delivered by Mr. Charles Evans, F.R.G.S., the leader, and by Mr. George Band, who was a member of the party that made the successful assault on the summit of Kangchenjunga. It was illustrated with colour films and slides and attracted a record audience of over 400.

During their visit the team were the guests of Westland Aircraft, Ltd., and of Normalair, Ltd., whose works they toured. The Sherpas, Da Tensing and Chang Ju, were given flights in

FROM ALL QUARTERS . . .

a Westland Dragonfly with other members of the expedition. The party showed particular interest in what they saw in the Normalair factory, as all the oxygen breathing equipment for the Expedition had been supplied by the company; and Mr. A. W. Bridge, manager of Normalair's industrial safety and medical division, was loaned by the company to the Royal Geographical Society to act as organizing secretary to the expedition.

The Midge Accident

AT the inquest, at Andover on September 28th, on Maj. Mathez, who lost his life in an accident to the Folland Midge, a detailed account of the circumstances was given by S/L. E. A. Tennant, the makers' chief test pilot.

He said he was at Chilbolton Airfield to give all the help he could to a Swiss Delegation who had come to inspect and fly the Midge. He flew the aircraft twice during the morning, and ascertained that it was completely serviceable. He then gave instructions to Mathez.

"When I briefed him I explained to him everything I could think of and went as far as setting the elevator trimmer, to the take-off position for him. He was an experienced pilot and he gave me to understand what I was telling him."

Mathez's take-off appeared quite normal for the first two-thirds of its length. "I then became alarmed when the aircraft did not leave the ground at a point one normally associates with take-off," said S/L. Tennant. "The nosewheel had actually risen but I could not see if the mainwheels were off the ground or not. At the end of the runway there was a puff of dust or smoke, which indicated he may have gone on to the grass overshoot. Almost immediately the Midge disappeared from my sight in a dip. It re-appeared shortly afterwards, climbing vertically with its nose up. The engine appeared normal throughout, and only stopped when it disappeared from my sight a second time."

Returning a verdict of death by misadventure, the Coroner said the aircraft was apparently in excellent order. "This," he added, "leads one to the conclusion that the crash did not take place because of any defect in the machine but possibly owing to the human factor."

Short Bros. Weapons Appointment

THE appointment is announced of Mr. J. Dent. B.Sc., A.M.I.Mech.E., as assistant chief engineer, guided weapons, at Short Brothers and Harland, Ltd.

For the past 11 years Mr. Dent has been principal scientific officer at the Admiralty Gunnery Establishment, Portland, where he worked on servo-mechanisms with the guided-weapons group. In 1950 he attended the first guided-weapon trials at Woomera, Australia. Mr. Dent was educated at King's College, London, served his apprenticeship with Rolls-Royce (Derby), and took his degree at London University.

Agricultural Aviation Show

THE world's first "agricultural aviation" display is being planned to coincide with the Seventh International Grasslands Congress, meeting in Palmerston North, New Zealand, in November of next year. It is reported that great interest is already being taken in the project, far beyond the confines of New Zealand. There are to be "live" exhibitions of aerial top-dressing, fence- and supply-dropping (in which practices New Zealand has so far outdistanced other countries) and of seeding, crop-dusting and spraying—in which other countries are, generally speaking, more advanced.

The Grasslands Conference will be held at Massey Agricultural College and the air show at Milsom aerodrome. The general plans have been agreed upon by interested organizations, and heavier aircraft than are at present operating as top-dressers and helicopters are likely to be demonstrated. The show may therefore widen out to an exhibition of much more than merely local interest and importance, in that overseas grassland authorities, concerned with increasing world food production, will evaluate the success of the specialized use of aircraft in New Zealand farming.

S.G.T.T. TEST HOUSE

DURING the past eleven years, the School of Gas Turbine Technology has provided instruction—for Service personnel and for students from all branches of industry and seats of learning—on the design, construction and operation of all forms of gas turbine. As students from all over the world will know, the School has previously been handicapped, in that, in order to provide actual engine trials on the syllabus, running time has had to be rented from one of the engine companies of the British industry—actually D. Napier and Son, Ltd. Last week the School was able to announce the opening of its own test house.

The 60 h.p. Rover engine drives a centrifugal pump in a closed hydraulic circuit, this arrangement being both flexible and providing for accurate power measurement.

The new building is situated a mile or so from the School, close to the National Gas Turbine Establishment at Pyestock, Hants. At present, it houses two engines which could hardly be more different; a Rolls-Royce Derwent turbojet and a Rover 1S.60 industrial shaft-drive engine.

The former is approximately a dozen years old and has been used by the School for a considerable time. Nevertheless, it appears to run excellently and is employed on all courses except that dealing specifically with industrial engines.

Illustrated here, the Rover installation is particularly noteworthy in that the shaft power is employed to drive a simple centrifugal pump in a closed circuit with a 500-gal water tank. At a rough guess, the entire hydraulic installation can have cost no more than a quarter of the price of a comprehensive dynamometer brake, although readings of torque cannot be obtained directly but must be determined from water pressures through venturis. Accuracy is, however, excellent.

The installation is fully instrumented for measuring the pressure and temperature at the various essential points, and demonstration runs can be used either to estimate the part-load performance of industrial engines or to establish the characteristics of turboprops for aircraft use. An unusual feature is the method of mounting the engine; it is supported entirely by the attachment face leading to the centrifugal pump, the loads then being taken out through the heavy water pipe. Hand-starting is provided, through which *Flight's* representative expended a considerable amount of energy.

Both engines are housed in the same cell, which occupies roughly three-quarters of the building. The remainder is equipped as an observation room which is capacious and excellently soundproofed. Instrumentation, comprising water and mercury manometers and a variety of dial gauges, are dispersed around three of the walls to facilitate the accommodation of large groups of students. Altogether the new installation seems to represent excellent value for money, and will undoubtedly greatly ease the problems attendant upon practical engine running for all future courses.

EXERCISE "BEWARE"

Progress and Conclusions

THE second phase of "Beware" occurred during last week, and was a continuation of the tactics and activities of the first phase. During the morning of the first day sporadic attacks by Canberras were made over the whole exercise area, but they were spotted well out to sea and intercepted in the north by Hunters from Leuchars and Sabres from Linton-on-Ouse. In the south the attacks came from a new direction—from the Brest Peninsula towards the coast between Plymouth and Beachy Head. Fighter Command here claimed a large number of interceptions over the French coast and in mid-Channel.

During the afternoon P.R. Canberras ranged over the northern part of the area while tactical atom-bomb carriers, probably F-84Fs, attacked over East Anglia from behind fighter cover. One F-84F would be masked by a swarm of fighters coming in at high level, and shortly before the target, the F-84F would dive down to almost ground level to drop its bomb.

In the early evening Canberras, temporarily based at Sola (Stavanger) and Gadermoen (Oslo) for another NATO exercise, flew across the North Sea to raid targets between Aberdeen and the Tay. They were intercepted well out to sea. During the night Canberras from Paris came in over Portsmouth, and attacked London. The final effort was by Canberras coming in towards London from the Wash. Javelins, now two in number, operated again from Coltishall. Each made two sorties and seven interceptions were claimed.

The Fleet Air Arm was operating for both sides, since in addition to flying "rat" sorties at low level, Sea Venoms were helping the night defences. American F-86Ds are now well integrated with the control systems and claimed many "kills" during Phase 2.

Not originally scheduled for "Beware" was an express spares-delivery service run by helicopters. It worked well and was a great asset, since spares urgently required, even by the radar stations and control points far from airfields, were delivered from the distribution point in the Midlands with the minimum delay. Less helpful, but just as important, was a series of infiltration raids on various establishments, designed to test security.

No longer able to show a clean pair of heels to the fighters, Canberra light bombers of Bomber Command were heavily engaged. At Honington, one of the many bomber stations active, maintenance work (top) and operations continued throughout the night. A crew are seen boarding their aircraft for a night raid. "Flight" photographs

With the new radar equipment and techniques, the Hunters, two of which are here taking off from Odiham, have undoubtedly been responsible for the great improvement in interception rates this year. Particularly striking has been the rapidity with which they can get airborne.

American aircraft based in England which took part in "Beware." An F-84F at Bentwaters (left) and an F-86D at Manston (right). "Flight" photographs

EXERCISE "BEWARE" . . .

Canberras at Honington. When "Beware" was at its peak, *Flight* visited the Bomber Command station at Honington, near Bury St. Edmunds. Commanded by G/C. G. T. B. Clayton, D.F.C., Honington was taken over by Bomber Command last February and is the base for four squadrons of Canberra B.2s —Nos. 10, 15, 44 (Rhodesia) and 57, commanded respectively by Squadron Leaders Sproates, Scott, Barling and Rothwell.

Through no fault of these officers or their crews, it proved impossible to discover how the exercise was progressing from the bomber's viewpoint; security instructions forbade disclosure of speeds, heights, targets and tactics of the attacking forces. Nor were the Canberra crews permitted to give their own version of their encounters with defending fighters. It was not possible, therefore, for observers here to form a balanced picture of this exercise as it was played out in the skies.

Throughout "Beware" Canberras were operating almost continuously from Honington. The operational aircraft from this base were all B.2s, though each squadron also has a T.4 trainer.

The sequence of events on a typical raid was as follows: Navigators' briefing, 1430 hr; main briefing, 1530 hr; flying meals, 1615 hr; to aircraft, 1715 hr; take-off, 1815 hr; return, 2125 hr. Aircraft were taking off and landing at intervals of approximately two minutes and, presumably, they made their attacks at similar intervals. After touch-down, each Canberra taxied to the operations-control block and halted briefly to enable the navigator-plotter to make his exit. This procedure effects a useful saving in time taken to complete the operational report for Group H.Q.

Honington is one of several R.A.F. stations now using the Decca A.C.R.7 radar—a Service version of the 424—as a let-down and approach aid. The equipment "came on the air" for the first time on the third day of the exercise and passed immediately into full operational use. The scanner for the A.C.R.7 is remotely mounted on a tripod at the edge of the runway and the controllers' consoles are set up in a screened enclosure within the air-traffic approach-control room. Though the equipment provides azimuth information only, the talk-down controller tells the pilot the altitude he should have at various ranges, thus giving him a "step-down" G.C.A. In practice, the rate of descent can usually be stabilized at a fairly early stage of the long, straight-in approach, and this procedure probably involves less "porpoising" than is normal with the full glide-path facility. By this means, it is hoped to achieve regular G.C.A. landings with a cloudbase as low as 100ft, compared with the present minimum of 400ft. Economy is one advantage of the Decca radar in its Service rôle; another is simplicity, with consequent ease of servicing and better reliability.

The operations block at Honington was of particular interest to observers who visited the first of Bomber Command's Canberra stations three or four years ago. While the aircraft—externally, at least—have not changed, the bases which launch them now reflect emphasis on the needs of the men who fly the bombers, as well as of the machines themselves. The standard operations-block layout adopted for such stations includes showers, for use after each flight, on-the-spot laundry service for flying clothing, and a large, comfortable crew-room with refreshments laid on.

The third phase, which took place last weekend, was to some extent restricted by bad weather on the Continent. Many attacking aircraft were unable to take off, particularly on Sunday, and the exercise finally finished "not with a bang, but a whimper." The last real engagement had been on Saturday when the defences dealt with two strong attacks, and claimed a number of kills.

At a Press conference at Fighter Command Headquarters, Air Marshal Sir Dermot Boyle, the A.O.C-in-C., summed up "Beware" as "an undoubted success." The defences had had to deal with attacking aircraft whose performance was superior to that of the equipment a possible enemy could bring against us at the present time. They had dealt with it efficiently at heights greater than ever before and further out to sea than ever before. Interception rates had been very high and the combination of new radar equipment and the Hunter fighters, together with new techniques, gave reason for a confidence we had not been able to feel before. Yet, since some of the bombers had got through, the C-in-C. expressed himself not entirely satisfied with results. But a defence commander could not be satisfied while a single bomber got through.

It is a major consideration that the new fighters would not have been of such value had not the supporting equipment been of a similar standard and its operation equally understood. This applied also to the Javelin which, the C-in-C. hoped, would "reach the squadrons in less than a year from now." Two Javelins, still M.o.S. property, had taken part in "Beware" and performed well. One of them was the eleventh production machine, with needle-nosed radome and the after fuselage somewhat deepened at the base of the fin. Both aircraft, in fact, had this deepened fuselage. W/C. E. D. Crew flew one of them, with S/L. J. Walton as radar operator. Eight Canberra silhouettes painted on the nose of his aircraft showed the number and nature of his kills in the exercise.

The American F-86D single-seat all-weather fighters of the 406th Fighter Interceptor Wing have now been integrated into Fighter Command and, after some modification of techniques on both sides, have become very effective. It was found difficult at first to fit in their collision-course tactics with our traditional stern-chase control, but this has now been resolved without abandoning the collision-course. But there is still a serious shortage of modern all-weather fighters.

It is encouraging that the defences should have remained largely effective even in the face of a great variety of feints and tricks of all types, and despite some extensive radar jamming. This last does not apparently render the situation "by any means impossible." The weather-actual reporting system worked well throughout, and communications by land-line were greatly assisted by the excellent work of G.P.O. engineers.

The C-in-C. concluded by saying that "what we stood up to is tougher than anything they could do to us now, either in quantity or quality." And with this knowledge and the hope of the improvement of the night-fighter forces, the air-defence picture can be viewed with something approaching real confidence.

The two Javelins at Coltishall during the exercise. The further machine is the eleventh production aircraft. The slightly raised fuselage top at the base of the fin can be seen at right.

HERE AND THERE

AERODUCK is the name of this great suction tank—an adaptation of a turf drier—designed to take up 400 gallons of water at a time from runways. The first is for Vickers-Armstrongs, and full production is under way at the Orpington works of Cimex-Fraser Tuson.

Royal Patronage for C.A.I.

FROM Ottawa it is reported that H.R.H. the Duke of Edinburgh has consented to become patron of the Canadian Aeronautical Institute, a body closely affiliated with the Royal Aeronautical Society and America's Institute of the Aeronautical Sciences.

A.Cdre. Harvey for Australia

WITH the object of discussing military and civil aviation at high level, A. Cdre. A. V. Harvey, C.B.E., M.P., deputy chairman of Handley Page, Ltd., left London by air last Sunday for Australia and the U.S.A.

At the French Embassy

HAVING been posted for duties at the pilot and navigation school at Avord, in France, the French Assistant Air Attaché in London, Cmdt. L. Andlauer, is succeeded by Cmdt. P. Chevalier. The newcomer served in No. 4 Group, Bomber Command, during 1944-45. The Air Attaché is Col. A. Puget.

New Hercules Order

THE Lockheed Aircraft Corporation announced last week a $100m (£35m) order from the U.S.A.F. for an undisclosed number of C-130 Hercules turboprop transports. Stated to be equivalent to one year's production of Hercules, the order, together with the existing backlog for this type, will keep the assembly line fully occupied until 1958. The value of one Hercules is believed to be approximately $2m. This was the fourth major order to be announced by Lockheed within a week; the other contracts, from civil operators, concerned 23 Super Constellations and 40 Electras.

H.P. on Training

SPEAKING on "The Art of Training" to the British Association for Commercial and Industrial Education at the College of Aeronautics, Cranfield, on October 1st, Sir Frederick Handley Page said: "You know Spurgeon's definition of a committee—'a noun of multitude signifying many but not much.' That, I feel, is the kind of thing you get unless the people at the top have a sufficiently real knowledge of the subject with which they have to deal so that they are not entirely dependent on advice given them by their advisers."

Talking Spares

ENTITLED "Repair or Replace," a discussion is to take place at the S.L.A.E. South-East meeting on Friday, October 14th, between I. Grant-Murray, M.S.L.A.E., chief inspector of B.E.A., J. H. McKeag, A.M.S.L.A.E., chief inspector, Britannia Fleet, B.O.A.C., and Mervyn Nixon, spares controller of the de Havilland Aircraft Company. The meeting, at 7.30 p.m., is at Mansion House, 26 Portland Place, London, W.1.

Off Lightly

EIGHT boys of between 13 and 15, accused of taking parts worth £69 from two aircraft at White Waltham during an air display, were conditionally discharged at Woking Juvenile Court last week on payment of two guineas costs in some cases and three in others. The prosecution said that damage estimated at £350 was done to the machines, which were parked in a hangar.

Do-s and Me-s

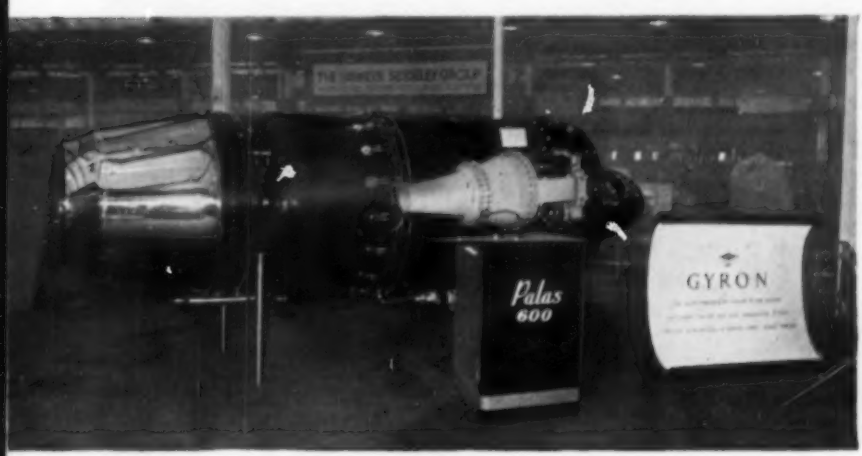
THE Dornier Do 27 two-seater (240 h.p. Continental engine) apparently impressed spectators at a public display of new West German powered aircraft and gliders at Munich on October 1st. As recorded in *Flight* on September 2nd, the aircraft recently made its first flight and it is reported that production is due to start soon. It was stated at the display that the Messerschmitt company also intends to start production of its Me 200 jet trainer (illustrated in *Flight* of August 26th) in Germany as well as in Spain.

One Man Show

AN exhibition of aeronautical, industrial and landscape paintings by David Shepherd was opened on Monday, October 3rd, by Sir Miles Thomas, chairman of B.O.A.C. At 24, Shepherd is the youngest member of the Society of Aviation Artists. The R.A.F. Benevolent Fund will benefit from the exhibition, which is being held at Parsons Gallery, 70 Grosvenor Street, New Bond Street, London, W.1; it will be open daily (Saturdays and Sundays excepted) until October 21st.

West Germany's Aircraft Industry

WEST GERMAN Radio reported last week that Herr Blank, the Federal Defence Minister, speaking in Dortmund on the build-up of the German defence forces, stated, *inter alia*, that the Defence Ministry would defray the reconstruction of the whole German aircraft industry



CHEEK BY JOWL are represented here the two extremes of turbojet thrust and bulk. The cheeky one is the Blackburn-Turboméca Palas 600, of 350 lb thrust. The jowlful one is the de Havilland Gyron, at an initial rating of 15,000 lb the most powerful of all.

AUSTRALIA'S OWN TRAINER: The first production Winjeels were recently handed over to the R.A.A.F. by the Commonwealth Aircraft Corporation at a ceremony at Laverton Airfield. Right, Air Marshal Sir John McCauley, Chief of the Air Staff, is seen receiving the log-books from Sir Laurence J. Wackett, C.A.C.'s general manager. The present order is for 62 Winjeels, powered with P. and W. Wasp Juniors.

HERE AND THERE . . .

from its ordinary budget funds. The building of aircraft would gradually begin, with the assistance of the central budget. A national economy like that of the Federal Republic, he said, could not forgo the production of aircraft.

For Looking it Up

THE index for Volume 67 of *Flight* (January-June, 1955) is now available, price 1s 1½d, including postage, from Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. An index and binding case together cost 6s 4d, with postage, or readers' copies can be accepted for binding at 18s 6d, a price which includes case, index and return postage.

Straws in the (Vertical) Wind

STANLEY HILLER, the helicopter constructor, said in Paris recently that in Britain and France there were developments in "flying bedsteads" and other vertical-flight aircraft that were ahead of what was being done in the United States. He could not elaborate on what he had seen, because it had been shown to him in secret. He added that in his view there was "more future" in such machines than in the normal helicopter, and that although his own company and its subsidiaries were still developing helicopters they were also actively working on other types of vertical-flight aircraft.

Good Reading for Motorists

IN connection with the forthcoming Motor Show, our associated journal *The Autocar* will be publishing three greatly enlarged special numbers. On Friday next, October 14th, the Show Guide will appear; in addition to a preview of the exhibits, it will contain descriptions and road tests of several important, completely new cars. On October 21st the Show Report will be published giving a stand-to-stand commentary on the Earls Court exhibits and containing at least one detailed description of a completely new car. The series will be completed on October 28th by the publication of the Show Review number. Two of these three issues will be sold at the normal price; the Show Report, three times normal size, will be priced at 2s.

WHAT GOES ON? This curious-looking operation is actually the picking-up of a radar-beacon framework from the deck of the arctic patrol ship H.M.C.S. "Labrador" for carriage to an otherwise unapproachable shore site. The R.C.N. helicopter is a Piasecki HUP-3.

Yet Another Helicopter Use

IN Australia recently, a helicopter was used to enable damages to be assessed for insurance purposes. The machine, which has been made available by the Navy, hovered over burned-out premises in Eagle Street, Brisbane, to enable photographs to be taken for the use of the assessors. The helicopter was utilized because the walls of the building were not considered strong enough to take the weight of ladders.

Photographic Merit

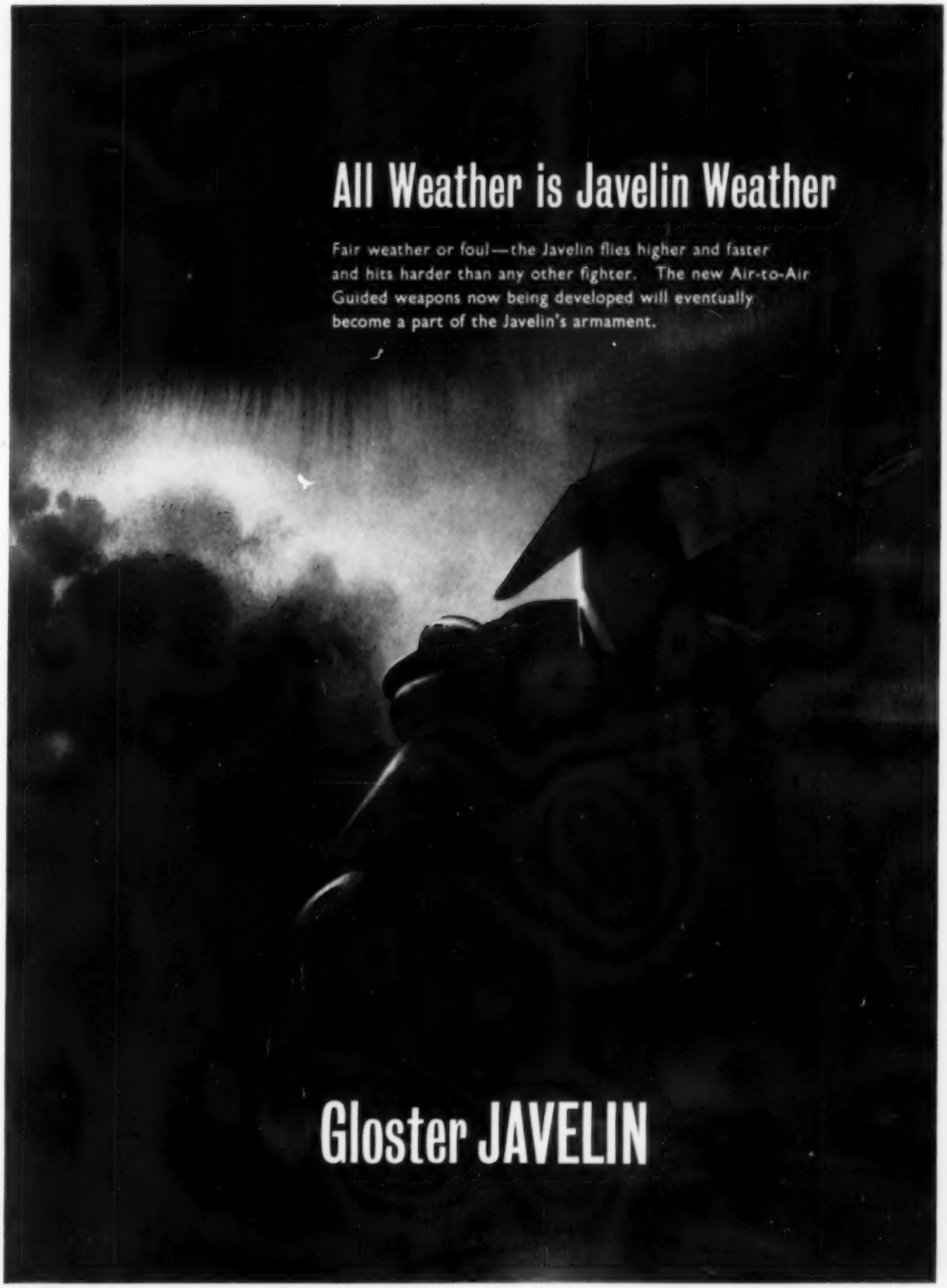
CHIEF photographer to the Hawker Siddeley Group, Russell Adams had one of his outstanding shots of No. 54 Squadron's Hunter aerobatic team accepted for inclusion in the Royal Photographic Society's annual exhibition, which was opened by the Lord Mayor of London on September 22nd. An electronics engineer by training, he began full-time photographic work only seven years ago. He was elected a Fellow of the Society largely on the strength of his air-to-air photography.

Antarctic Intentions—

FROM Wellington, New Zealand, it is reported that S/L. J. R. Claydon, R.N.Z.A.F., is shortly leaving for Britain to join the British advance party of the 1957-58 Antarctic expedition. It is rumoured that S/L. Claydon may eventually command the R.N.Z.A.F. element of the party from the Dominion, which will join the expedition. Another of the New Zealanders is Sir Edmund Hillary.

—and Uranium

AUSTRALIA will begin a search next year for uranium on the Antarctic continent. A Beaver is now being equipped with a scintillometer and will be employed for geological surveys by the research expedition to be sent next year to the Australian Antarctic base at Mawson in MacRobertson Land. The expedition will leave Melbourne at the end of December to relieve the party which has wintered at Mawson this year.


All Weather is Javelin Weather
Fair weather or foul—the Javelin flies higher and faster and hits harder than any other fighter. The new Air-to-Air Guided weapons now being developed will eventually become a part of the Javelin's armament.
Gloster JAVELIN

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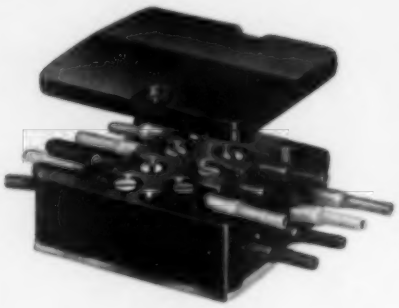
The new Plessey range of superior relays, comprising Open, Dust Cover or Gasket or Hermetically Sealed types, is both reliable and consistent over protracted periods of use and, individually, the relays have unusually good 'G' characteristics. And a recent advancement in the form of improved magnetic circuitry has made possible a lighter, more compact product having greater contact pressures and clearances.

Plessey publication 772, containing complete details, diagrams and tables, is available free to manufacturers—see that your Design Engineers have a copy.



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HIGH-SPEED DRONE

A New Canadian Approach to Target-aircraft Design: The Caeta Project

AMONG the projects under way at the Montreal plant of Canadian Aviation Electronics, Ltd., on the occasion of a recent *Flight* visit, was the design of a radio-controlled target aircraft capable of high subsonic speeds. This machine, known as the model P-1, or Caeta (from the initials of Canadian Aviation Electronics Target Aircraft), has been put forward to meet a specific need, and in a most original way.

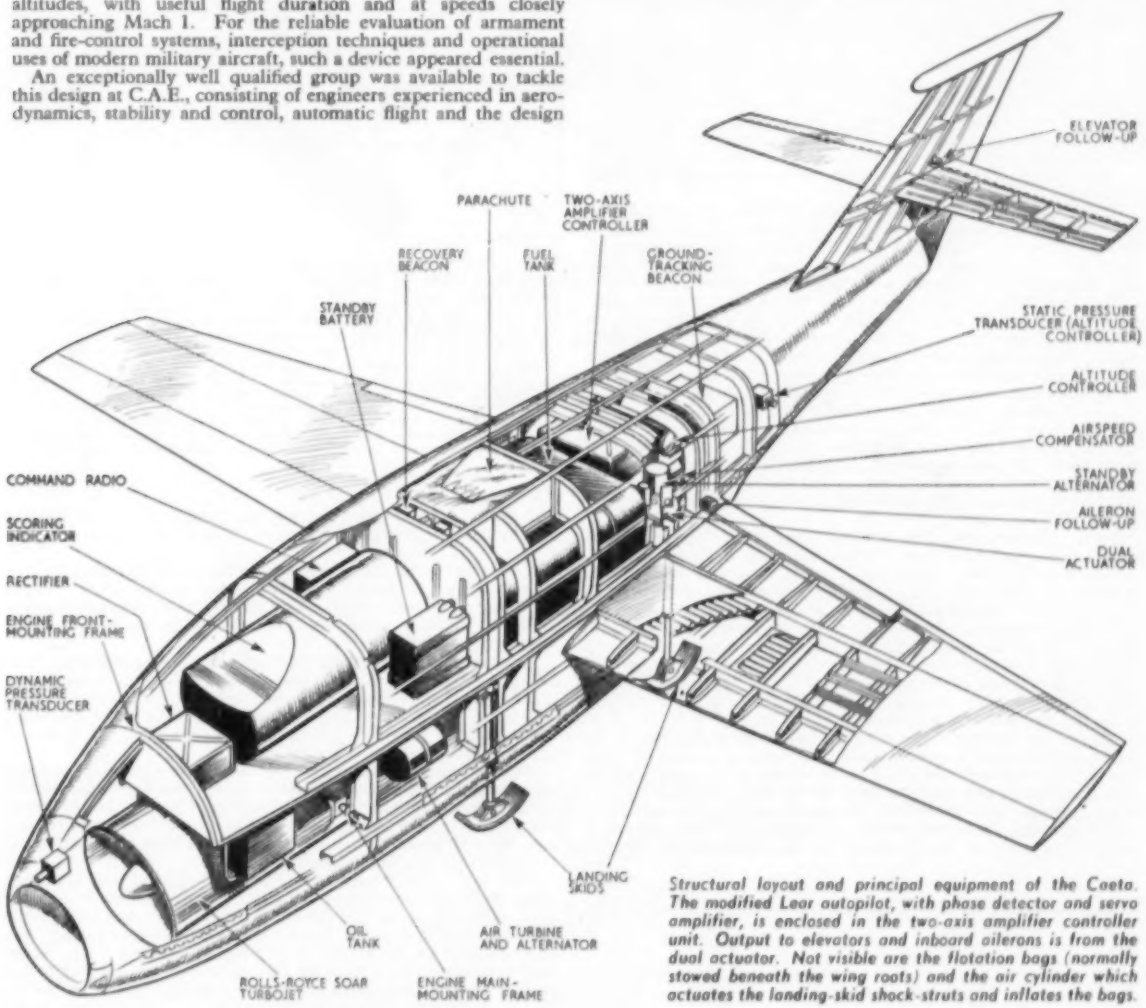
An investigation by the company showed that nowhere was there available a target aircraft capable of operation at extreme altitudes, with useful flight duration and at speeds closely approaching Mach 1. For the reliable evaluation of armament and fire-control systems, interception techniques and operational uses of modern military aircraft, such a device appeared essential.

An exceptionally well qualified group was available to tackle this design at C.A.E., consisting of engineers experienced in aerodynamics, stability and control, automatic flight and the design of electronic systems. Previous work on flight and radar simulators had given the aerodynamicists in particular an unusually extensive knowledge and appreciation of electronic systems; and the result of the team's effort and previous background was the design described below.

The performance of the drone was to match that of bomber aircraft which might be used over the next decade. Mach numbers between 0.9 and 1.0 were to be achieved over the entire altitude range, which was from sea level to 60,000ft, and a half-hour endurance at this upper height was specified. Ground-launching and air-launching were both to be practicable, and the radius of command control was to be 100 miles and 50 miles respectively.

Design studies indicated that a simple target aircraft, weighing no more than 1,500 lb and powered by one Rolls-Royce RSr. 2 Soar turbojet, could be designed rapidly and would form a suitable platform for the required equipment. The airframe would be conventional and, provided the wing thickness/chord ratio did not exceed six per cent, sweepback would not be required.

For control and guidance, it was decided to use existing equipment as far as possible, for reasons of reliability and speed of production. A simplified version of the Lear F-5 autopilot, with rudder control deleted and a single actuator adapted to operate both elevators and ailerons, was selected. At this stage a complete general arrangement, of mid-wing configuration, was drawn up. The high tailplane required a fairly high fin thickness/chord ratio, and so considerable sweepback was given to the fin; this



Structural layout and principal equipment of the Caeta. The modified Lear autopilot, with phase detector and servo amplifier, is enclosed in the two-axis amplifier controller unit. Output to elevators and inboard ailerons is from the dual actuator. Not visible are the flotation bags (normally stowed beneath the wing roots) and the air cylinder which actuates the landing-skid shock-struts and inflates the bags.

HIGH SPEED DRONE . . .

of course, had the effect of lengthening the tailplane moment arm.

Although the appearance of the aircraft was conventional, the basic philosophy came from a novel—and singularly logical—viewpoint. The machine is not primarily an aircraft, with the available space filled with electronics. Neither is it primarily a piece of electronic equipment, with wings, tail and powerplant added. Instead, principles of integrated design have been adopted in which the drone as a whole is viewed against the background of its operational requirements.

As an example of this approach, the ultimate strength factor is decided by weighing structural criteria against the intended use of the target since, with most of the aircraft's useful life intended to be spent at 60,000ft, it would be uneconomical to design to strength factors as specified for current fighters. On the other hand, weighing the structural criteria against the performance requirements and the desire to employ the simplest possible autopilot, the need for high structural rigidity is apparent in order that the autopilot does not have to cope with extreme aeroelastic influences.

The aerodynamic characteristics, weighed against the intended use of the drone, show that a rate of roll representative of a bomber at altitude is sufficient and that the rolling criteria for fighter aircraft need not be applied. Small ailerons are therefore incorporated which, placed inboard on the wing, avoid excessive aeroelastic distortion of the wing. Such small ailerons do not make large torque demands on the autopilot actuator, which may therefore be simplified; and, because of the low hinge moment of the ailerons, there is no necessity for providing aerodynamic balance.

The electronics system, in addition to the airframe, is also considerably simplified by using an integrated design approach; the low ultimate strength factors of the airframe and the intended short life of the complete drone make possible the use of lighter and overloaded components, with consequent reduction in cost.

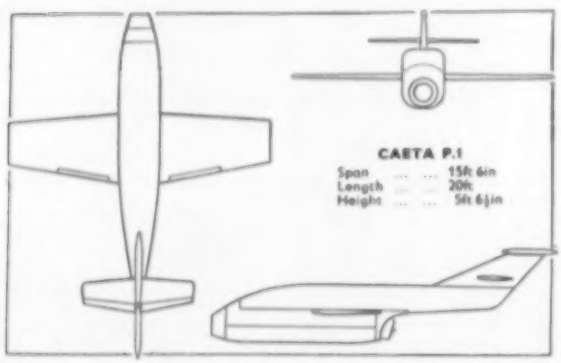
The design philosophy, then, was based on the assumption that the proposed target aircraft would be fundamentally a vehicle to house and transport electronic equipment. Its ability would depend upon radio guidance systems, from both ground and air, and information channels to pass data back to the pilot flying the intercepter and to the target controller.

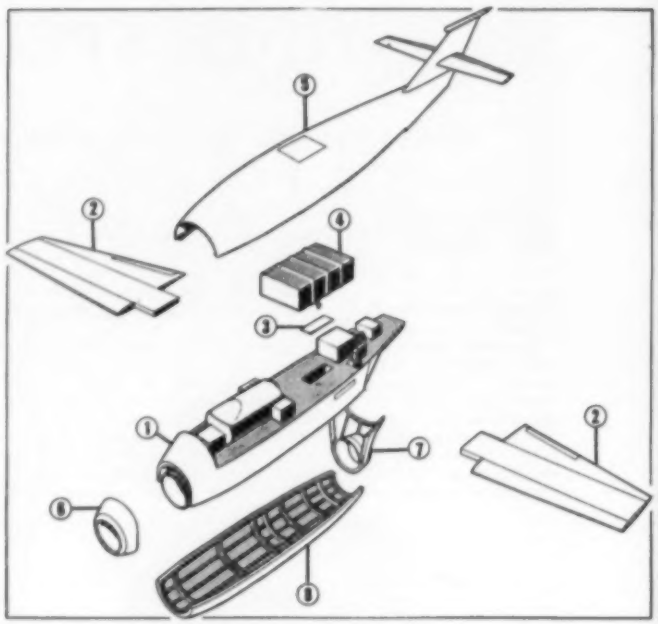
As a practical economic consideration, the target aircraft would require an electronic method of establishing and recording the accuracy of air-to-air and ground-to-air firing with all forms of armament. This must ensure (1) a high order of scoring accuracy, (2) that a direct hit on the target would not be necessary, and (3) that instantaneous score information would be transmitted to the intercepter.

Other considerations were that the target should be recoverable (from both land and water) with minimum damage; the airframe should remain operational throughout and beyond the service life of the engine; and that the aircraft should be capable of rapid and economical production at the minimum cost.

Design Features. Borrowing from electronic practice, the design is based on what might be termed the chassis. This is a horizontal centre-fuselage member carrying all the electronic equipment above deck and the engine below. Economical line-production methods are made possible by this method, which also eases the problem of maintenance.

The centre fuselage is the principal structural member to which all equipment inertia loads, mainplane loads and landing loads are directly applied. Above it is fitted the top fuselage, which transmits the fin and tailplane loads to the centre fuselage. Other main fuselage sections are the air intake, and the engine fairing (fitted beneath the centre fuselage). Apart from the removable top-section feature, the fuselage follows conventional practice and is of the semi-monocoque type. Top fuselage and engine fairing are attached to the centre fuselage by means of piano hinges.





Assembly sequence for major components of the Caeta:— Centre-fuselage member (1) with equipment installed is first placed on trestles and circuits checked. Wings (2) are then slid into place, shear pins attached, centre joint bolted up (access joined through removable stressed panel (3) which is then replaced), and aileron control linkage to autopilot actuator connected. Fuel tank (4) is positioned and fuel lines connected. Top fuselage (5) is next lowered into place, attached by piano hinge to (1), and elevator linkage and cables to vertical tail are connected. Intake fairing (6) and exit fairing (7) are then attached by quick-release fasteners, and engine fairing (8) by piano hinge, to (1). Caeta is then ready for installation in take-off carriage or parent aircraft, after which it is fuelled and the compressed-air cylinder charged through access panels. For storage, only (1) requires environmental control, since it carries all equipment sensitive to temperature and humidity.

The wing being thin, bending resistance is provided by distributed flange material which forms the exterior skin, stiffened by a corrugated inner skin. The number of corrugations is progressively reduced outboard to accommodate the decrease in spanwise bending moment.

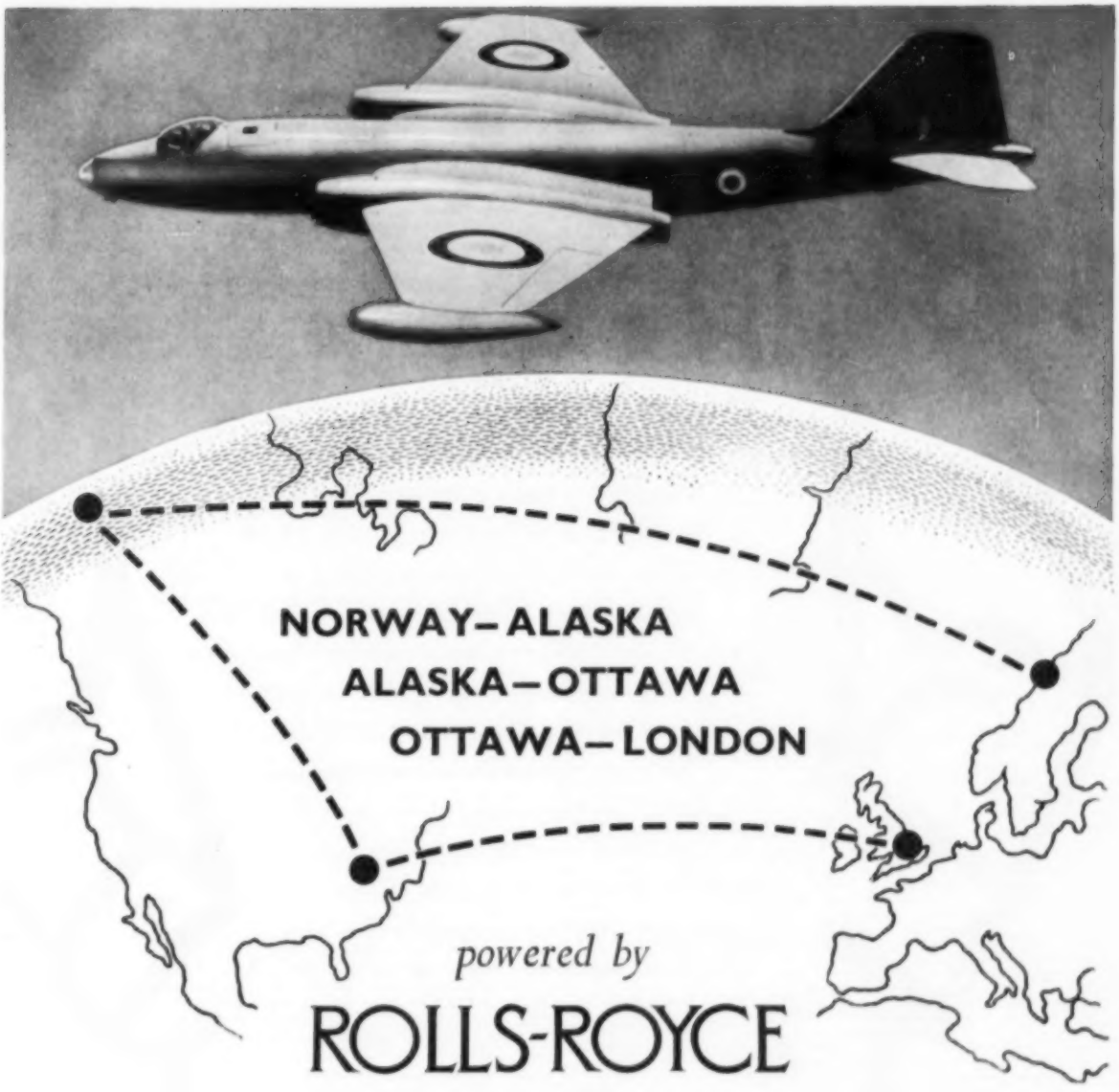
The fin is a conventional stressed-skin structure, having continuous spars fore and aft, together with an auxiliary spar, from the root to the tailplane, which here branches into two extruded stiffeners. The tailplane consists of a skin mounted on two spanwise extruded stiffeners and an integral framework of spars and ribs machined from magnesium alloy.

The powerplant chosen for the aircraft—mainly for reasons of exceptional thrust/weight ratio, small overall dimensions and comparatively low cost—is the Rolls-Royce Soar, of 1,860 lb thrust. Although designed with a clean exterior to permit external mounting, the Soar is here mounted internally, mainly to provide protection for the engine on landing.

The fuel system comprises the main flexible bag-type fuel tank, in which is installed a booster pump, and the main feed and return lines to the engine. Fitted with the engine is a high-pressure fuel pump, having a delivery volume greater than that required by the engine in any flight condition. The excess fuel is returned via a separate line to actuate the booster pump, which feeds the main fuel line to the engine. A trap within the fuel tank provides fuel to the engine for a period of 15 sec under negative acceleration.

Power to drive the various systems and services is derived from a three-per-cent air bleed from the fifth compressor stage, driving a constant-speed turbine on which is mounted a Lear alternator (1kVA, 400 cycles, 115 volts A.C.). Since both A.C. and D.C. power are required, a selenium metal rectifier is included in the power take-off system, and supplies D.C. at 27.5 volts.

Control and Guidance. The control and guidance system for the Caeta is intended to provide positive stability characteristics throughout the flight range of Mach number and altitude and to permit the aircraft to be manœuvred and steered at any stage of its flight path. To accomplish this, a modified Lear F-5 autopilot is used to provide stability; and command signals to the



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HIGH SPEED DRONE . . .

autopilot are fed in through a modified CTRC-26 receiver.

The autopilot is of the two-axis type, and detects roll and pitch errors by means of a single position gyro. A rate signal is obtained by taking the derivative of this signal, by means of a network. Variations in overall autopilot gain, made necessary by the requirements for large control displacements at low speeds and low altitudes and at high speeds at high altitudes, and for small deflections at high speed and low altitudes, are obtained from a variable-gain amplifier monitored by the dynamic pressure of the airstream. This section of the autopilot comprises a dynamic pressure transducer together with an airspeed compensator.

In order to maintain constant altitude, a signal from a static pressure transducer monitors the elevator signal. To obtain internal loop stability in the autopilot control surface, deflection and rate-of-deflection signals are fed back into the servo amplifier.

Output to the control surfaces is from a modified Lear autopilot actuator. This consists of a single 27.5 volt D.C. motor running continuously in one direction and driving the control-surface linkages in the appropriate direction through magnetic clutches (two per control) which are activated by signals from the amplifier controller unit. Coaxial with the actuator motor is installed a 400-cycle, 115-volt alternator which provides standby power for the autopilot.

The command radio employs a frequency-modulated sub-carrier multiplex system to ensure that positive and reliable communications between target and control station are maintained at all times. Twelve sub-carriers provide six command channels and are spaced at 200 c.p.s. intervals from 1,000 to 3,400 c.p.s. These provide elevator up and down, aileron right and left, engine speed increase and decrease, and altitude hold (engage and release) signals, together with two spare double-signal channels.

In normal flight, the Caeta is controlled through this command radio system by signals applied to the autopilot amplifier controller and to the engine speed control servomotor. In the case of a ground launch, a take-off trolley is used, from which the target flies off after reaching its take-off speed of approximately 110 m.p.h. The climb is performed with the aid of a climb-path curve on the ground controller's elevation radar scope (similar in principle to a G.C.A. glide-path approach) and, when operating altitude is reached, the aircraft may be steered over a predetermined path drawn on the P.P.I. at the controller's station. Possible air-launching installations envisaged are in the bomb bay of a Lancaster and at the wingtip of a CF-100, in which cases the command transmitting equipment would be carried in the parent aircraft.

The recovery sequence commences when the engine is stopped due to a deliberate command, loss of command, or to lack of fuel. The standby power system is then brought into operation, and an aileron-deflection signal is fed into the autopilot, causing the machine to descend along a spiral path. When a pre-set altitude has been reached, the "aileron up" signal is disengaged and an "altitude hold" signal imposed. The aircraft ultimately stalls straight and level, after which the parachute is released, landing gear is extended, flotation bags are inflated and recovery-beacon transmission is begun.

The airborne radar equipment consists of a tracking system and a scoring system. The former comprises a tracking beacon, which gives the controlling station an accurate plot of the target's position; in addition, a scintillating beacon or corner reflectors would provide a radar echo for the intercepting aircraft. Consideration has been given to the use of one of two scoring indicators, one (based on Doppler radar principles) being developed in the U.S.A. and the other, a frequency-modulated continuous-wave radar system, of C.A.E. design. The C.A.E. system has been so designed as to give miss-distance and trajectory of a projectile fired at a region fixed in relation to the target aircraft, but separated from it by a distance large enough to minimize the risk of destroying the machine.

Recovery Equipment. The standby power supply consists of a 27.5 volt D.C. battery of the Sonotone sintered-plate nickel cadmium type. Upon closure of the engine throttle, the battery output is switched to the command receiver and to the D.C. motor in the autopilot control-surfaces actuator, and power for the A.C. section of the autopilot is generated by the standby alternator. Thus control and guidance of the aircraft are maintained during the initial phase of the descent.

When the aircraft has reached a preset altitude, and has stalled following the "altitude hold" command given by the barometric switch, a 36-foot diameter parachute is released by means of a simple electrical actuator. The landing gear is simple, consisting of four small oleo pneumatic shock struts fed from a common air cylinder. The shock struts are normally stowed within the lower front fuselage and are extended by compressed air from the cylinder when the parachute is released. Four small skids, so designed that they rotate into the direction of landing, are fitted to the free ends of the shock-absorber struts.

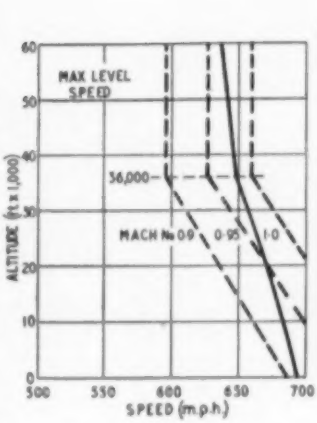


Fig. 1. Speed performance.

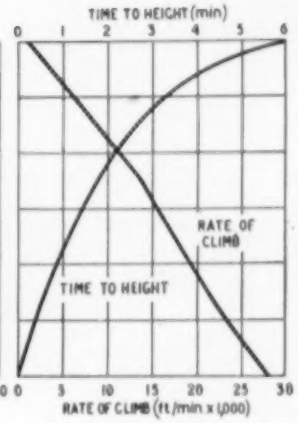


Fig. 2. Climb performance.

The flotation equipment consists of non-return valves in the lines from the fuel tank, to prevent its flooding if a descent is made into water; and two inflatable bags normally stowed in a recess below each wing root. The bags are inflated from the partitioned air cylinder which extends the shock struts.

In order to locate the Caeta after landing, a form of self-contained beacon is required, and the SARAH V.H.F. rescue beacon has been adopted for this. It is stowed just forward of the parachute bay; release of the parachute extends the beacon antenna, which then transmits continuously for 24 hours.

At Montreal, the Caeta design group, under Mr. John Martin, have completed their detailed design study (including complete performance, stability, stress, and air-load analyses; structural design; and preliminary autopilot and command system analysis), and the project has been put forward for appraisal by the R.C.A.F. One main advantage for Service use seen in the design is that the centre-fuselage "chassis" is the only item requiring storage in a controlled environment; the airframe "cabinet" requires little maintenance.

Unhampered by a tradition of producing airframes and, as an afterthought, fitting in the "black boxes," C.A.E. have made possible great economies in their new approach to a wholly integrated design. Simplicity in maintenance and operational flexibility have also been built into the Caeta project.

Concerning possible production of the machine, it is estimated that the first prototype could be completed and ready for testing eleven months after the placing of an order. The company is offering the design to the R.A.F. and U.S.A.F. in addition to the R.C.A.F., and intends to negotiate actively with all NATO countries in the near future.

In the event of a manufacturing contract being received, prototype units only would be produced by C.A.E. at Montreal. Series production of airframes would be licensed to an appropriate aircraft manufacturer, according to Mr. K. R. Patrick, president of the company. So far the Caeta programme at C.A.E. has been carried on as a private venture without Government sponsorship, although much advice and information from the R.C.A.F. and U.S.A.F. have been incorporated in the design work over the past two years.

P-1 CAETA TARGET DRONE

(Rolls-Royce Soar Turbojet, 1,960 lb static thrust at sea level)

Dimensions:—

Span	15 ft 6 in
Length	20 ft
Height	5 ft 6½ in
Gross wing area	52.8 sq ft
Aspect ratio	4.55
Elevator area	2.66 sq ft
Aileron area	1.44 sq ft

Weights (lb):—

Structure	390
Powerplant	319
Electronics	156
Autopilot	45
Power services	42
Recovery equipment	88
Fuel and oil	334
Gross	1,374

Performance:—

For a ground launch, at a take-off weight of 1,395 lb (40 Imp. gal fuel), the endurance at 60,000ft, following 2½ min at full power at sea level and a climb to 60,000ft is estimated to be 19.3 min.

For an air launch at 30,000ft, the endurance at 60,000ft, following a 2½-min run-up at 30,000ft and a climb to 60,000ft, is estimated to be 29.1 min.

Fig. 1 shows the variation of maximum level speed (solid line) with height, and Fig. 2 the rate of climb and time to height. Mach number at 60,000ft is 0.96, compared with 0.98 at 40,000ft and 0.91 at sea level. Sea-level rate of climb is 27,500ft/min, compared with 19,250ft/min at 20,000ft; 11,500ft/min at 40,000ft; and 6,000ft/min at 50,000ft.

Distinguished chiefly by its laterally bulged torpedo bay, the Grumman S2F-2 is now replacing the S2F-1 in U.S. Navy service. Also evident in this photograph is the curious streamlined aerial housing above the cockpit, referred to in a paragraph below.

AIRCRAFT INTELLIGENCE

Great Britain

English Electric P.1. We believe that the three-view drawing of the second prototype, reproduced below, is the most accurate and detailed which has yet been published. For the first time, the rear-fuselage air brakes are correctly shown, flanking the jetpipes. Other features not previously depicted are the aileron mass balances (outboard) and flush horn balances (inboard); the manner in which the leading edge droops; and the recessed "saw-cut" channels further outboard, which act as fences and improve flow over the ailerons, particularly at low speeds. The roundels on the upper surface of the wings are exceptionally large.

Handley Page Victor. According to the European Correspondent of *American Aviation*, the first production Victor B.1 is almost ready to fly, and was at one time a possible participant in the recent S.B.A.C. display. It is described as having a lower-set tailplane, a revised vertical tail and a rather longer nose.

U.S.A.

Grumman S2F-1 Sentinel. Although we understand that it still suffers from such faults as excessive airframe vibration, the S2F is now fully established in carrier service with the U.S. Navy. The first unit to use the type was VS-23, which embarked in U.S.S. *Princeton* in the winter of 1954 for a Pacific tour. More recently, VS-26 has been active in the Mediterranean, aboard *Antietam*. At least one machine of VS-26 carries a large and blunt acorn-like fairing—possibly covering electronic gear—on a pylon projecting upwards from the flight deck. On other S2Fs, a two-legged mast is mounted here, carrying a smaller device at its top.

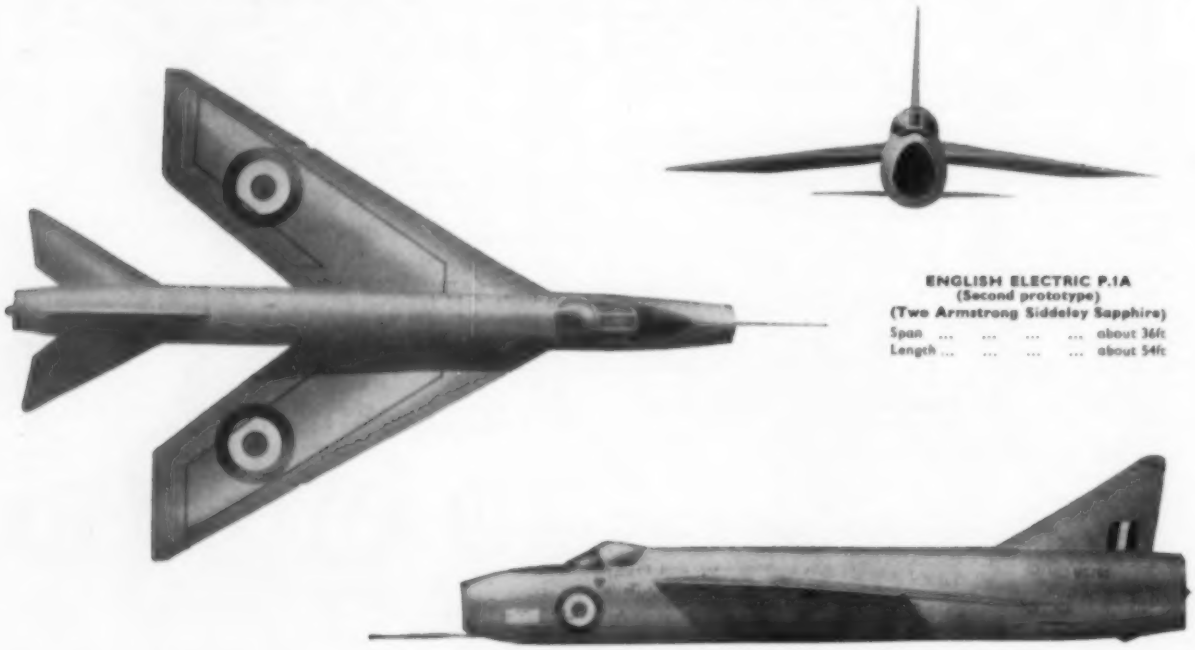
France

Bréguet Naval ASW machines. The second prototype Bréguet 960-01 (Mamba + Nene) has been fitted with a special wing in order to flight-test the boundary-layer-control blowing system. Ground tests are complete, and Yves Bruneau will soon fly the machine at Toulouse. The 965 (Mamba only) recently concluded its maker's trials, as well as radar testing carried out at the Cuers naval air station; is now being tested by the French Navy at Marignane. The ultimate production version, Type 1050, will fly next year.

Fouga CM.170 Magister. All 13 pre-production Magisters have now been completed, and the first of the main batch (machine No. 14) will fly shortly. The first prototype CM.170M, the fully navalized version, is now rapidly taking shape and is to fly at the beginning of next year. Also scheduled to fly early in 1956 is the CM.171, a test aircraft for the CM.195 swept-wing, butterfly-tailed trainer powered by two Turboméca Gabizos. There is also a projected CM.191, to be a four-seat liaison machine, but it is unlikely that this will be built.

India

Hindustan Projects. While the production of Cirrus-powered HT-2s remains the major manufacturing item at the Government-owned Hindustan Aircraft plant in Bangalore, various later designs are being considered for production. The Twin-Wasp-powered HT-10 advanced trainer is still in the prototype stage, and this may be dropped in favour of a light jet machine for basic military training. Turboméca or Blackburn-Turboméca powerplants are probable for this design. Hindustan are also in the final design stages of an "advanced jet fighter" and a "medium transport." In addition, as reported last week, interest has been shown in the Folland Gnat.

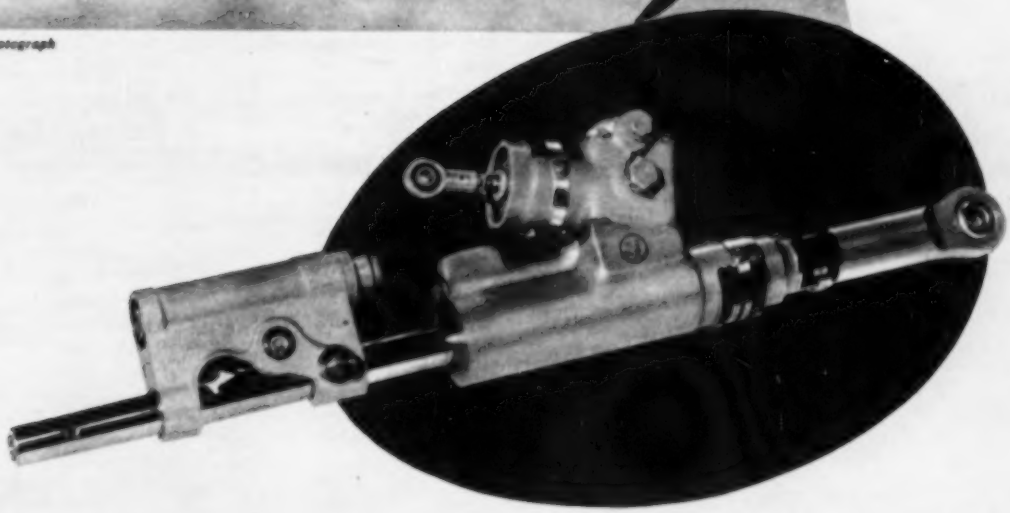


ENGLISH ELECTRIC P.1A
(Second prototype)
(Two Armstrong Siddeley Sapphire)

Span ... ... about 36ft
Length ... ... about 54ft

"*FLIGHT*" Photograph

flying to fine limits



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Aeronautical Research in Canada

Eleventh British Commonwealth and Empire Lecture

By Dr. J. J. GREEN*

THE full title of this most important Royal Aeronautical Society lecture, which was read at the Royal Institution, Albemarle Street, London, yesterday, was *The Growth of Aeronautical Research in Canada During the Post-War Decade*. It may be recalled that last year the author of the tenth lecture was the Duke of Edinburgh, whose subject was *Aviation and the Development of Remote Areas*.

In spite of the title of his lecture, Dr. Green naturally gave a brief historical survey of research in Canada before turning to the post-war decade. The concise manner in which he traced the beginnings and the progress of research since 1902 renders this introductory section most valuable for record purposes.

Dr. Green said that Canada's first wind tunnel was built in 1902 at Rothesay, New Brunswick, by W. Rupert Turnbull and it was here that aeronautical research in Canada had its birth. A Fellow of the Royal Aeronautical Society and an Honorary Fellow of the Canadian Aeronautical Institute, Dr. Turnbull won the bronze medal of the Society in 1911 and at the time of his death in 1954 at the age of 84 he was maintaining his interest in aviation and studying the art of bird flight. The results of his wind tunnel studies of aerofoils, in which he was seeking automatic stability, were published in full in the *Physical Review* in 1907.

For the study of propellers in axial motion he built himself a 300-ft track, with a little carriage to carry the propeller and its driving motor. He published three papers, one on *The Efficiency of Aerial Propellers* in the *Scientific American*, and two papers in the Journal of the R.Ae.S. on *The Laws of Airscrews*. After the First World War he designed a controllable-pitch airscrew which was successfully tested at Camp Borden by the R.C.A.F. He sold his patent rights to the Curtiss-Wright Company and from these the Curtiss electric propeller was developed.

Aeronautical development in Canada began about the same time, also in the Maritime Provinces. At Baddeck, Nova Scotia, Alexander Graham Bell was experimenting with novel designs of kites from which, by the application of power, he hoped to achieve flight at the least possible risk of human life. He was greatly interested in the work done by Professor Langley, who in 1894 visited Baddeck to witness some of Dr. Bell's own experiments. Two years later Dr. Bell saw a trial flight of Langley's "Aerodrome." The sight of this steam-powered model traversing the sky impressed him enormously. In his own words "Encouraged and stimulated by this remarkable exhibition of success I quietly continued my experiments in my Nova Scotia Laboratory in the hope that I, too, might be able to contribute something to the world's knowledge of this important subject."

In 1907, Glenn Curtiss, whose light gasoline engines had earned him a reputation, was invited to Baddeck to advise Dr. Bell on the application of power to his tetrahedral kites. Two young Canadians, J. A. D. McCurdy and F. W. "Casey" Baldwin, were invited to consult with Bell on the structural details. From this meeting, the Aerial Experiment Association was formed and four successful aircraft were built between 1908 and 1909. The first flight of "Red Wing" on March 12, 1908, at Hammondsport, N.Y., by F. W. Baldwin was claimed as the first flight by a British subject, while McCurdy's flight at Baddeck on February 23rd, 1909, in the "Silver Dart," was claimed as the first flight within the Empire. This group of development engineers were the first to employ ailerons for lateral control. Mr. McCurdy tells me how he was explaining his method of lateral control by little wings to a French pioneer who, comprehending, exclaimed "Ah! ailerons" and the name stuck.

Dr. Green's next historical references concerned the latter part of the 1914-18 war. He said that the first Canadian University to take a serious interest in aeronautics was that of Toronto, which established an aerodynamic research laboratory in 1917 at the instigation of Mr. J. H. Parkin, then on the engineering teaching staff. The University recognized that aviation would play a part in the development of Canada and at the same time that Canada would impose on air transportation unique operating conditions. In 1918 the University constructed its first wind tunnel, a 4ft N.P.L.-type with a speed of 37 m.p.h. This was replaced in 1923 by a more efficient tunnel of the same size working section but having a wind speed of 60 m.p.h.

These University facilities were used for training and research and also for testing models of aircraft under development by the Canadian Aircraft Industry. The researches were mostly of an engineering nature and were concerned with aircraft problems, such as the interference between wings and fuselages, the relative efficiencies of various wing tips, the downwash behind wings, the aerodynamic effects of wing taper and the influence of thick wings in biplane arrangements.

During these years a Canadian company bearing the illustrious name of Vickers designed a number of aircraft well-remembered in Canada but with names which the lecturer thought must sound strange to the ears of his audience: the Vigil and the Velos and the flying boats Vedette, Varuna, Vanessa, Vancouver and Vista. Models of these aircraft were all tested in the Toronto University wind tunnel before being built and flown. Mr. B. S. Shenstone wrote a very fine thesis based on an exhaustive analysis of the flight stability of the popular and successful flying boat, the Vedette. A single-engined machine, it was used by the R.C.A.F. for forestry patrol and aerial photography.

On February 7th, 1920, the first meeting took place of the Associate Air Research Committee, which was created by the National Research Council at the request of the Canadian Air Board (forerunner of the R.C.A.F.). Its first task was to survey the university facilities which might be available for aeronautical research purposes. Among the subjects listed by the Committee in 1920 for special attention were photography as applied to topographical survey, experimental and theoretical studies of aeroplane stability, air navigation problems, especially as regarded the use of directional wireless, propulsion and the possibilities of variable pitch propellers and the physiological effects of flying. Many of these subjects did receive attention in the 10 years that followed. Turnbull's controllable pitch propeller, although several years in advance of its time, was completed and ground-tested in 1923. Loss of the propeller in a fire delayed the air tests until 1927.

At Alberta University, Professor C. A. Robb tackled the problems of aero engines at low temperatures. Over a number of winters, he conducted experiments on engine operation, with special reference to starting difficulties and the effect of temperature on lubrication and cooling.

At this stage, Dr. Green also referred to the work of Professor L. V. King of McGill, Professor Bronson of Dalhousie, Mr. Stanley Smith at Alberta and Mr. Parkin at Toronto.

In 1929 the Government authorized the construction of aeronautical laboratories by the National Research Council. These included a 9ft open jet wind tunnel with a maximum speed of 230ft/sec, a model testing basin some 400ft long, an engine testing laboratory and later, an aircraft instrument section and a fuel and lubricants laboratory.

In 1935 the study of aircraft icing was begun in a serious way. The first experiments were concerned with keeping propellers free of ice and the idea was conceived that the right way to do this was by electrical heating.

In 1939, with international tension mounting, new and expanded aeronautical laboratories were designed by the N.R.C. to serve the anticipated needs of the R.C.A.F. and industry. A slightly larger wind tunnel with double the speed of the 9ft tunnel was built and a modern spinning tunnel was provided. A new model basin was added with greater length and width and a modern engine laboratory was constructed. Two important new laboratories were included, an aircraft structures and a low-temperature laboratory. New and improved fuel and lubricant and aircraft instrument laboratories were also provided.

Looking back on the war period, said Dr. Green, a modest contribution to basic knowledge was made here and there. A multitude of small jobs, mostly uninspiring and unspectacular, were done under pressure and urgency, but they scarcely made interesting history. If they added but little to general knowledge, they had at least enhanced the experience and competence of the staff.

At the end of the war the National Research Council had a well-experienced and mature staff of fairly adequate size. Their facilities had proved to be well-suited to the war needs. The opportunity now arose to direct their capabilities into fundamental research channels, and such a policy was accepted, although while the emphasis was to be on research, it was agreed that the laboratories would continue wherever possible to assist the industry, which had also grown and matured during the war.

Next Dr. Green referred to the Government decision to participate actively in the gas turbine field, and the initial step of creating Turbo Research, Ltd., a Crown company. Shortly after the end of the war, the Canadian Government also decided

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AERONAUTICAL RESEARCH IN CANADA . . .

for the first time to support the development of military aircraft in Canada through a then-new company, A. V. Roe Canada, Ltd. This company also assumed the gas turbine development responsibilities of Turbo Research, Ltd., and the research functions were given to the National Research Council, Turbo Research disappearing from the scene. N.R.C. began to plan an expansion of its equipment and Toronto and McGill Universities took action to meet the demand for scientists and engineers with advanced training.

After this historical introduction to the subject, Dr. Green turned to the main body of his lecture arranged under a variety of research headings. On the subject of **aerodynamics**, the lecturer first examined the arrival at the University of Toronto in 1947 of Dr. G. N. Patterson. He took up the post of Professor of Aerodynamics, having recently completed studies in the new field of stationary and non-stationary supersonic flow. Graduate students under Dr. Patterson's training did good work with a 2in by 7in shock tube and a 1in by 1in intermittent blow-down supersonic tunnel during the next two years.

In 1949 the Defence Research Board, which had been created two years earlier to be responsible for the application of science to defence matters, entered into an agreement with the University of Toronto for the construction and operation of an Institute of Aerophysics, with Dr. Patterson as its director. The establishment was to train scientific personnel for research and development in the basic physics of gases, applied aerodynamics and ballistics, with special emphasis on supersonic flight. It was also to engage in aerophysics research and to develop practical applications therefrom. Design work started at once on a 16in by 16in supersonic wind tunnel of the closed jet, intermittent type, in which air flowed from a specially constructed moisture-proofed room (capacity 36,000 cu ft) through the tunnel and into a 40-ft diameter evacuated sphere. The tunnel, which had a running time of about 25 sec, had been operated up to a Mach number of 2.92.

The 2in by 7in shock tube had been a most useful research tool during the past seven years. It consisted of four steel sections giving a total length of 11ft when assembled. The compression chamber could be pressurized to 4 atmospheres and the expansion chamber evacuated to less than 1 mm Hg. A schlieren optical system used initially had been replaced by a large-field Mach-Zehnder interferometer. Shock-wave velocity was obtained by a schlieren photo-cell system which provided electrical trigger pulses from the passage of the shock-wave.

Recently a 2in by 2in strong-shock tube of 24ft length had been constructed for the study of shock-waves at Mach numbers up to 20. Explosive mixtures of hydrogen and oxygen were used in the high-pressure chamber to initiate the strong shocks. The diaphragm between the high- and low-pressure chambers was of brass, scribed to control its rupturing characteristics.

This year a low-density tunnel for the study of slip and free molecule flow had been provided. The tunnel was continuous in operation, and with an open-jet test section (maximum diameter 5in) and vacuum-pump drive. It would operate from subsonic speeds up to a Mach number of 5.0.

The old R.A.E-type open-return tunnel of the University of Toronto was replaced in 1952 by a conventional return type, closed-section subsonic tunnel with a 9:1 contraction ratio. The new tunnel had a top speed of 160 m.p.h. in a 32in by 48in test section for a power expenditure of 60 h.p. It was used for training and, to an increasing extent, for research by graduate students.

The National Research Council had also added a high-speed aerodynamics laboratory to its facilities, the first supersonic tunnel being placed in operation in March 1951. This had a 10in by 10in working section. A second, 30in by 16in, high-speed tunnel was added in September 1952, and in December a transonic section was developed in this tunnel. Both tunnels were of the intermittent type and operated from a common vacuum consisting of two steel spheres with a total capacity of 56,000 cu ft. With this capacity, running times of 15 seconds and 70 seconds were obtained with the larger and smaller tunnels, respectively, and three to five runs per hour could be made.

Concluding his description of new aerodynamic facilities, Dr. Green said that mention must be made of the aeroballistic range at the Canadian Armament Research and Development Establishment. This consisted of a concrete building approximately 20ft square and 760ft long. One end was closed except for an inlet hole through which the models entered. The other end of the range was open to permit the models to be trapped in a large sand-butt. The models under test were launched from a smooth-bore gun by means of a discarding sabot. The sabot protected the model from blast effects or mechanical damage while in the barrel and permitted the launching of odd-shaped models. The sabot was of four-petal construction and these petals opened and scattered rapidly from the line of fire on emerging from the barrel. The sabot petals were caught by a sheet of armour plate which prevented their entry to the range. The model under test passed through a 9in hole in the armour plate and entered the range. Launching guns of 3.125 in and 5.9 calibre had been used up to the present time, enabling the testing of fairly large-scale models. Velocities up to 4,000ft/sec had been employed. Inside the range the velocity of the models was determined every 50ft by light screens. A spark shadowgraph-schlieren system employing 36in diameter mirrors was used for photographing the model and the airflow around it (Fig. 1). Yaw cards were employed to give the angular orientation of the model and its displacement from the line of fire as well as its roll orientation.

The next subject discussed by Dr. Green was that of **gas dynamics**. It was in 1949, he recalled, that the governors of McGill University authorized the construction of a laboratory for this purpose directed by Professor D. L. Mordell. This laboratory, which was located 16 miles west of Montreal, contained six sound-proofed test cells with a total floor area of 4,000 sq ft. The following were the chief items of equipment:—

(a) A compressor test rig with a capacity of 2,000 b.h.p. at 9,500 r.p.m., the power being provided directly by the power turbine of a modified Bristol Theseus turboprop. The air-measuring system could handle up to 60 lb/sec and electronic traverse instruments and recording gear were installed.

(b) A turbine test stand capable of absorbing up to 1,000 b.h.p. This was at present being used for the development of an experimental coal-burning turbine.

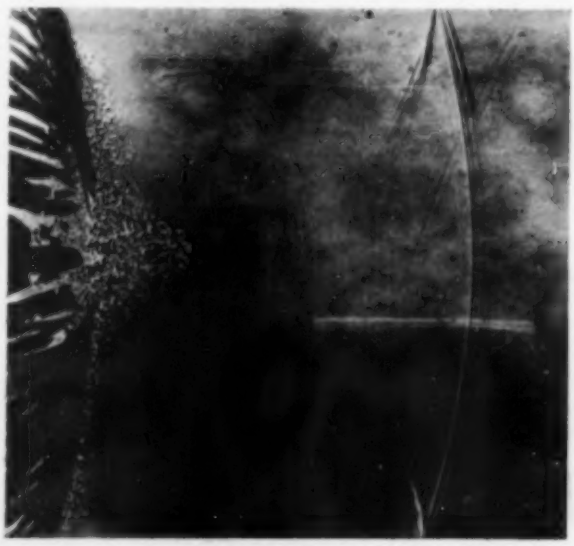
(c) A pair of engine-driven compressors for the supply of compressed air; the capacities were respectively 4 lb/sec at 4 atmospheres and 2 lb/sec at 1.5 atmospheres.

(d) Two turbine/supercharger units. One was driven by a wave compressor and motor which allowed tests to be done on both compressor and turbine; the other had its own combustion chamber and was operated as a turbojet.

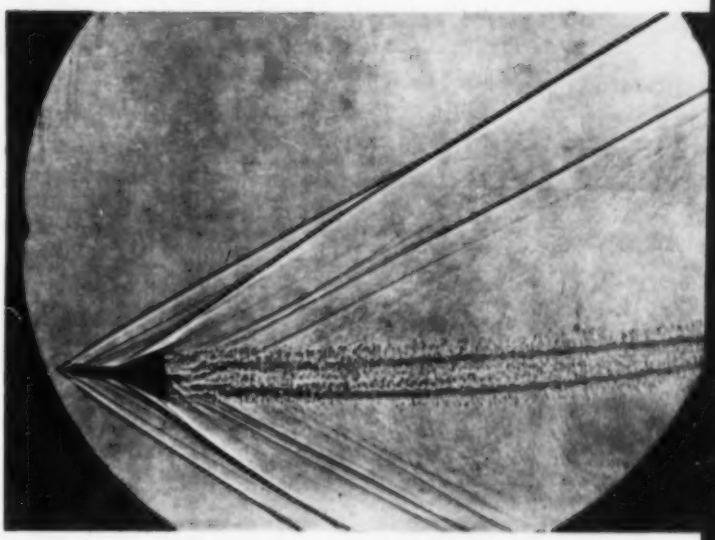
(e) A general laboratory of some 1,500 sq ft used for small-scale testing, and supplied with compressed air and propane.

In 1948, the National Research Council also undertook research in this field, with the construction of a compressor and exhauster plant, various facilities for combustion research, and equipment for the study of flow through the blades of compressors and turbines. While awaiting completion of the design and construction of a high-speed compressor/turbine test-bed, an annular wind tunnel was provided for boundary layer investigations on rotors and on isolated blading at low lift coefficients. The second item of equipment installed was a suction tunnel capable of supporting single drops of liquid for indefinite periods in order to assist experiments upon fuel droplets in airstreams.

The compressor and exhauster plant was completed in 1953, the 6,000 horse-power multi-stage, two-cylinder centrifugal compressor delivering 31.4 lb/sec at a pressure of seven atmospheres, or 53 lb/sec with a pressure ratio of 2.25 : 1. The 2,800 horse-power centrifugal exhauster, with an intake pressure between 0.05 and 0.25 atmospheres, delivered 800 cu ft/sec when discharging to atmosphere. Test equipment comprised a 2,000 horse-power three-stage suction turbine, a single-stage compressor test-bed



Rupture of the diaphragm and propagation of the shock-wave at a pressure ratio of 2.0 in the shock tube of the Institute of Aerophysics laboratory of the University of Toronto.



An excellent photograph from the aeroballistic range, showing a delta-winged model (reminiscent of a Canadian missile) rolling, pitching and yawing at a Mach number greater than 2.0. The curvature of the wake and the trailing vortices from the tip ailerons are noteworthy.

with a pressurized circuit and a 1,000 b.h.p. single-stage pressure turbine with a hydraulic brake for power absorption.

New equipment assembled last year included a test rig for afterburners, with an annular combustion chamber for pre-heating, a water-cooled restrictor to simulate the turbine pressure-drop, and a reheat pipe and nozzle for the afterburner testing. Additional rigs for high-altitude combustion studies and the investigation of high-rate heat transfer had also been provided.

The lecturer then turned his attention to **structures**. He pointed out that the Canadian aircraft industry embarked on several important design and development projects (such as the Avro Aircraft CF-100 and CF-102 and the Canadair North Star) at the end of World War II. Concurrently the National Research Council agreed to provide static test facilities to assist these projects, the N.R.C. installing hydraulic testing equipment for wings up to approximately 120ft span.

Four reinforced concrete beams were installed flush with a floor of similar construction. Two of these beams, on 15ft centres, were 100ft long and the other two, similarly spaced, were 85ft long and were provided to permit tests on swept wings. The superstructure comprised steel frames, each designed to carry a vertical load of 60,000 lb. Main loads were applied by undercarriage jacks from Lancasters, each having a 24in stroke with a capacity of 23,000 lb in tension. Loads were applied to the wing through sponge-rubber adhesive tension patches bonded to the surface.

Deflection was measured by *ad hoc* boards on which small weights were suspended by music wires running over pulleys, and thence to the various points at which the deflection was required to be measured, supplemented by dial gauges at the wing root attachments. Strain was measured by strain gauges coupled to multi-channel recorders.

In addition to this massive installation, the N.R.C. also had a 600,000-lb universal testing machine capable of accommodating specimens 19ft long in tension and 22ft long in compression, provision also being made for large bending tests. The machine was hydraulically operated with a separate weighing system accurate to one-half of one per cent.

Dr. Green emphasized that a great deal of specialized equipment for the measurement of dynamic strain, pressures, vibrations and accelerations had been developed within the laboratory. Particular ingenuity had been shown in the design and manufacture of specific equipment or models for basic research in the fields of aero elasticity and fatigue.

Dr. Green then went on to outline the development of **flight research** in Canada. It was, he said, soon recognized that a flight research establishment under the direct control of scientists was a necessity, and in 1946 the R.C.A.F. agreed to provide facilities for the N.R.C. and a joint unit was set up at an *ad hoc* airfield at Arnprior, some 40 miles from Ottawa. Personnel of the Flight Research Section were divided roughly equally between the N.R.C. and the R.C.A.F. and, by 1945, some dozen aircraft were employed, comprising Mustangs, Ansons, Harvards and a Norseman and Expeditor. A considerable variety of specialized instrumentation and equipment was devised by the staff. In July 1953, the Section was transferred to Uplands Airport, Ottawa, which provided better airfield facilities.

Canada's equivalent of Boscombe Down was the R.C.A.F. Central Experimental and Proving Establishment at Rockliffe, near Ottawa. While the role of the C.E.P.E. had been predominantly testing and assessment, it had also contributed materially to development, and had worked closely with the N.R.C. Flight Research Establishment.

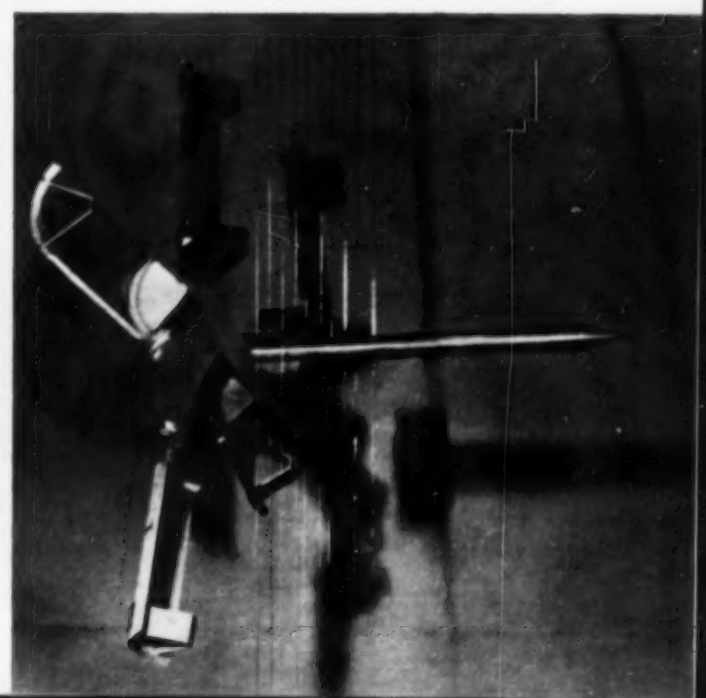
The next subject discussed by Dr. Green was one in which Canada plays a particularly important part, namely **climatic testing**. Canada had always been particularly concerned with the influence of low temperature on men and equipment, and the British Ministry of Supply and aircraft industry had looked to Canada for advice and assistance in such matters. For the most part, such problems had been investigated by field tests but it had always been recognized that this had introduced its own difficulties, not the least of which had been the control of conditions.

Immediately after the war, the N.R.C. provided extensive facilities in the low-temperature laboratory of the Division of Mechanical Engineering. The refrigeration plant, one of the largest of its kind in Canada, was a three-stage direct-expansion ammonia system, having a capacity of 250 tons and a total driving power of 1,000 h.p. Three cold chambers were available, two being 10ft square with a height of 8ft and the largest 15ft wide and high and 51ft long. Each of these chambers could be lowered to minus 80 deg F. Wind velocities up to 50 miles per hour could be produced by auxiliary fans and internal combustion engines of up to 160 h.p. could be run continuously in these chambers.

To assist in the development of aircraft de-icing equipment, two special tunnels had been provided. One of these was a closed-return tunnel driven by a 1,000-h.p. motor which could produce an airspeed of 200 m.p.h. in the 4½ft working section, the icing cloud being provided by a water spray at the start of the contraction. The second tunnel was of the blower type, to provide a higher speed for basic research and tests of small components. This tunnel took air from the down-stream side of the refrigerating coils of the main tunnel and returned it to the up-stream side. Its 50-h.p. centrifugal fan could establish a velocity of 500 m.p.h. in the 5in by 8in working section. In 1949 the R.C.A.F. made available a specially equipped North Star for comprehensive icing trials, and this powerful and long-range aircraft had proved eminently satisfactory for all forms of de-icing experiments.

Dr. Green also referred to the Winter Experimental Establishment of the R.C.A.F. located at Edmonton, Alberta. Although not specifically concerned with research matters, the W.E.E. had accumulated a wealth of knowledge regarding solution of operational problems caused by low temperature.

The remainder of Dr. Green's paper will be summarized in our next issue. In this, the author deals with a variety of other types of research.



An outstandingly clear photograph (one of a Fastax series at 5,000 frames/sec) of a model at 1,500ft/sec in the aeroballistic range. The sabot carrier is just breaking up into its four petals. The vertical wires are employed for flash-triggering.

MODERN AIR SURVEY TECHNIQUE

Points from the Commonwealth Survey Officers' Conference

THE papers submitted to the 1955 Commonwealth Survey Officers' Conference, held recently at Cambridge, were of a highly specialized nature, those on air survey subjects dealing more with surveying techniques and with the results yielded thereby than with the flying aspect. Indeed, the aeroplane was a notable absentee at the otherwise comprehensive exhibition of survey instruments displayed for the conference—partly, no doubt, for purely practical reasons and partly because many of the aircraft used in civilian survey work are adaptations of familiar military types; the Lockheed P-38 Lightning, D.H. Mosquito, and B-17 Flying Fortress are examples that come to mind. The C-47 Dakota has also been widely used for this purpose, and it was of particular interest to read in a paper entitled *An Aerial Survey Operation Overseas*, by W. P. Smith (Air Survey Co., Ltd.) that a Dakota was used for high-altitude photographic survey in the Zambesi River valley last year. The operating height was 25,000ft and the aircraft was fitted with Pratt and Whitney R-1830-90C engines.

A point that emerged in the discussions at the conference is the fact that aircraft are playing an essential part in mapping operations in rôles other than the principal one of carrying the surveying camera; in addition to transporting men and equipment over the long distances involved in the routine work of Colonial surveying, aircraft of both fixed- and rotary-wing types are being increasingly used for flying surveyors directly to the points on high ground from which the basic visual triangulation observations have to be made. The helicopter is already making a major contribution in this and similar rôles, and one which will further increase when performance under tropical conditions and at high altitudes is improved.

The papers submitted to the conference were necessarily esoteric in their appeal, but there emerged from them, and from the ensuing discussions, two points of wider interest; first, the way in which different countries have adapted the techniques of navigation and survey photography to their own conditions and technical resources and, secondly, the progress that has already been made, and will evidently continue, in the use of electronic devices for navigating the survey aircraft and for securing the actual survey data.

Both these points were well brought out in a paper—*Modern Survey Methods Adapted to Canadian Conditions*—presented by Mr. W. H. Miller, Director of the Surveys and Mapping Branch of the Department of Mines and Technical Surveys, Dominion of Canada, and prepared by Mr. E. J. White, Topographic Survey, and Lt.-Col. J. I. Thompson, Army Survey Establishment.

The first part of this paper dealt with a new photographic technique developed in Canada and known as the bi-camera method. In this technique, the aircraft carries two cameras, one pointed vertically downward in the conventional manner and one mounted obliquely and directed in the line of flight with its axis depressed approximately 30 deg from the horizontal. The angle of depression of the oblique camera is such that the photograph will include both the horizon and a small portion of the area covered by the vertical camera. The effect of this arrangement, coupled with the process of photogrammetric analysis, is that the pictures of the terrain ahead, taken by the forward-looking camera and later photographed again by the vertical camera, markedly reduce certain errors which accrue when survey measurements are carried out along a strip of photographs.

Use of Shoran

The second part of the paper was devoted to the use of the Shoran secondary-radar position-fixing system in Canada since 1948. Shoran consists essentially of an airborne transmitter which triggers-off two (or more) ground beacon stations, receiving and display equipment in the aircraft enabling the distances from it to the beacons to be precisely determined. By flying along the right bisector between two stations, the system can be used to measure the inter-station distance; the measurement of lines in this way, averaging about 200 miles in length, is the basis of trilateration surveying (as opposed to triangulation), and the technique has been used over a large area of Canada with great success. Most of the mainland of Northern Canada has been covered by Shoran trilateration nets, over 90 stations having been established.

Shoran is also used as a position-fixing system for the aircraft, whereby the aerial photographs taken on a survey can be assigned their correct positions on the earth's surface. Since 1948 Shoran has been extensively used in Canada for the control of air photography, first by the R.C.A.F., and later by contract to civilian firms. About 55,000 square miles were covered in the first contract, and in 1953 the same contractor made the most of good photographic weather and of the lessons learned from the previous year, covering over 132,000 square miles. The 1954 season was equally successful, and in three seasons a lattice of Shoran-controlled photography spaced at about 20-mile intervals covered 80 map-sheets of 1/250,000 scale—an area of 330,000 square miles. The Canadian paper also referred to the increasing use of radio altimeters for "vertical control" in air survey.

Electronic aids to surveying have come into being only in the decade since the war, and the recent Survey Officers' Conference was the first of a series held at roughly four-yearly intervals to include a paper devoted entirely to this subject. (*Radio Aids to Surveying*, by Mr. C. Powell, of the Decca Navigator Co., Ltd.) After a review of current radio and radar position-fixing systems, in which it was shown that the wavelength on which the system operates determines within close limits its operational scope, the author described the Decca Navigator system in detail, with special reference to its current use in various types of survey operation. On the air side, an interesting example was the control of the accurate navigation required for large-scale air photography over the U.K. for map revision by Ordnance Survey. The use of Decca had been specified for this work for some years past and was made necessary by the close spacing of the parallel photographic tracks and the high accuracy of tracking required (e.g., plus or minus 20 yards at the large photographic scales used).

The Decca Navigator, being a long-wave system, could be used by low-flying aircraft which would be unable to receive the transmissions of systems based on radar techniques. For this reason, Decca lent itself for use in geophysical survey operations and for the navigation of helicopters and other relatively low-flying aircraft flying on survey operations over featureless country. Comparatively little experience had so far been obtained on the use of the system for the control of high-altitude photo-survey aircraft, but it showed considerable promise in this direction, particularly in view of the light weight of the airborne equipment. Trials were at present in progress.

Survey in Africa

Recent and current aerial survey work on the African continent was described in a paper (*Aerial Photography in Nigeria*, by Mr. H. A. Stamers Smith, Director of Federal Surveys). The first aerial photography of Nigeria of any magnitude was by the trimetrogon process, using three airborne cameras, carried out by the United States Army Air Force during World War 2, and covering some 250,000 square miles. After various abortive attempts under extremely bad weather conditions, the Royal Air Force started in September 1949 to cover further large areas of the country and by 1951 had mapped a total of about 150,000 square miles.

Radar tracking had been used in much of this work, and a lesson learned was that an aerial survey in a country of variable and capricious weather should be planned from the outset to cover a large area, tackling it in sections as weather permitted, rather than specifying a relatively small region in which photography might be impossible for long periods.

Concurrently with the photography by the R.A.F., the Survey Department of Nigeria chartered a de Havilland Dove from West African Airways Corporation for departmental aerial photography, and this work was continuing up to the present time. The total photographic coverage by the Survey Department had been about 124,600 square miles. The aircraft was fitted with a Williamson survey sight by which drift was measured and the necessary course correction made, and an order had been placed for a navigating sight designed specifically for aerial photography, also manufactured by Williamson. Despite the stability of the Dove visual tracking was a considerable problem.

The papers referred to have been concerned with the means of aerial surveying. It is perhaps appropriate to conclude this brief review of a few of the conference papers by mentioning one of those that dealt more with the end-product of the survey. The paper, entitled *Aerial Photography and Resources Surveys*, was by Mr. T. D. Weatherhead, director and general manager, Hunting Aerosurveys, Ltd., and Mr. V. C. Robertson, manager, Resources Surveys Department, Hunting Aerosurveys, Ltd. The principal product of an air survey is a topographical map, and this, the authors pointed out, was the essential basis of all development work in the area concerned. Equally important, however, was the preparation of maps recording land use, soils, forestry and geology, these being grouped under the general heading of "resources surveys." Aerial photography played just as vital a part in the production of a resources survey as in the making of a topographic map, and the paper included examples of this type of survey operation.

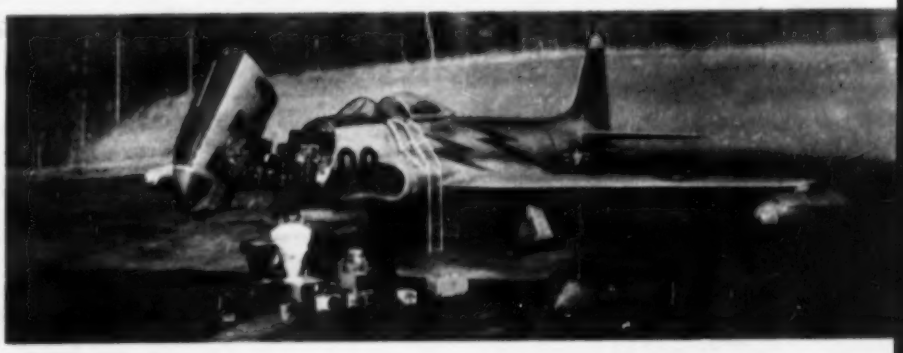
Politics and Tactics

HAD President Eisenhower's novel suggestion of aerial inspection of the U.S.A. by the Soviet Union and *vice versa* been accepted by the latter country it is likely that the first sortie from the West would have been flown by the U.S.A.F.'s 10th Tactical Reconnaissance Wing. A part of the United States Air Forces in Europe (Lt-Gen. William H. Tunner), the Wing is a formation of the 12th Air Force, and is also *ipso facto* part of the 4th Allied Tactical Air Force.

Until this year the Wing was equipped with Lockheed RF-80C Shooting Stars (centre photograph) and with piston-engined Douglas RB-26 Invaders. Now the latter have all been replaced by glistening black Martin RB-57 Canberras (above), fresh from Plant 2 at Baltimore. Far-ranging, and equipped with a very advanced camera installation, these machines could, if need be, photograph the whole of European Russia. The RF-80 Shooting Stars, on the other hand, are employed for more strictly tactical work, at all levels.

From their base at Spangdahlem, in what was formerly the American Zone, the aircraft of the 10th Wing cover most of Germany in their incessant training missions. Two of their low-level photographs are reproduced here: the beautiful schloss (castle) of Schonburg at Oberwesel (right, below) and the equally famous towers of Hohensalzburg, near Salzburg in Austria.

A full account of tactical photography was published in our issues of October 1st and 8th, 1954 (describing methods used in Exercise "Battle Royal"), and an A.T.A.F. conference on tactical photography was reported on November 12th. In the latter account appeared a photograph of the new F.95 camera, carried by the RB-57.



ARMY HANDMAID

Design of the Fairey Ultra-light Helicopter

AIRCRAFT designed to operate in the field with a fighting army have to fulfil a number of requirements which are rarely met elsewhere. In addition to the obvious need for a machine capable of operation from simple, unprepared plots of ground, Army requirements frequently specify that all equipment shall be capable of being uplifted and carried long distances on ordinary Army vehicles. Superimposed on all other requirements is the fact that it has to be of an essentially simple and rugged nature, capable of standing up to arduous conditions in all parts of the world with the minimum of expert attention.

At present, the principal aircraft used by the British Army are the various types of Auster, of which the A.O.P.9 is the most efficient. This aircraft, which was fully described in our issue of June 11th, 1954, is steadily being delivered for use in a variety of rôles. Notwithstanding the proven capability and versatility of this type of machine, however, there are certain duties which it cannot tackle; yet these duties would be quite straightforward undertakings for a helicopter.

Only the U.S.A. has been able to buy army helicopters on a large scale. This Service employs many hundreds of helicopters for duties which include front-line resupply and casualty evacuation, logistic support and a variety of combat procedures, some highly unconventional. Our own Army cannot afford such equipment and has bought its helicopters (Dragonflies and Sycamores) one or two at a time. It has long been appreciated, however, that a rotating-wing aircraft could be developed specifically for Army requirements which would be invaluable in certain important rôles, while representing a considerably smaller financial outlay than do the types of helicopter previously mentioned.

During 1953 the War Office collaborated with the Air Ministry and the Ministry of Supply in the formulation of a comprehensive specification for a simple Army helicopter. The principal rôle was to be that of an air observation post with provision for equipment for secondary rôles of casualty evacuation, training and other miscellaneous functions. A moderate endurance was deemed acceptable, but arduous requirements for an outstanding vertical performance were laid down, both for temperate and for tropical operation. The specification called for an operating crew of two and required that the aircraft should be capable of being quickly dismantled and transported in a standard three-ton lorry.

Put out to general tender by the industry, the specification drew forth six or seven designs, that submitted by the Fairey Aviation Co., Ltd., of Hayes, Middlesex, winning the contract in July last year. In that month the order for a small batch of prototypes was placed by the Ministry of Supply and design work started in earnest.

From the outset the Fairey designers had strongly inclined to the view that tip drive was highly desirable for such an aircraft. Obviously, a very simple machine could be designed, driven by ramjets or pulsejets; but exhaustive studies suggested that, at the present overall state of development of such power units, such a helicopter could not be made compatible with the specification. On the other hand, the Army's requirements were ideally suited to the pressure-jet helicopter, with which Faireys already had considerable experience as a result of their long-term research (principally carried out with the Jet Gyrodyne) in the field of large transport helicopters. Preliminary studies showed that a pressure-jet helicopter could be designed to meet the specification fully.

KEY TO DRAWING

1 Mesh-guarded intake on each side.
2 Blackburn-Turboméca Palouste.
3 Lagged air duct to rotor.
4 Jet efflux impinging on rudder.
5 Fuel tank box (bag inside).
6 Fuel filler (50+ Imp. gal).
7 Temporary fuel pump mounting.
8 Seat for pilot facing forward.
9 Collective pitch/throttle lever.
10 Cyclic pitch to tilting head.
11 Rudder pedals and cables.
12 Fly-bar and bob weights on rotor.
13 Fuel lines to tip burners.
14 Wood-filled metal-clad skids.
15 Boom transport joint (bolted).
16 Airspeed pressure head.
17 Ground-handling wheel axle holes.

FAIREY ULTRA-LIGHT HELICOPTER

(Blackburn-Turboméca Palouste BnPa.2, with 258 gas horse-power available)

Principal dimensions: rotor diameter, 28ft 3½in; overall height, 7ft 11in; overall width (rotor blades fore-and-aft), 6ft 3in. Weights and performance details not yet available for publication.

This "Flight" photograph, studied in conjunction with the drawing opposite, gives an excellent idea of the Ultra-light's compactness. Note the small rotor diameter, which has enabled a direct tilting-head type of control to be employed.

Fortunately, there was an obvious powerplant already available from a British manufacturer. This was the Turboméca Palouste, re-engineered by Blackburn and General Aircraft, Ltd. The original French engine first ran several years ago and is now a reliable and well-proven unit. The Blackburn engine not only has provision for a far more comprehensive range of accessories but employs a turbine machined from Nimonic 90 alloy, as a result of which the engine can run hotter and give somewhat more power than its French prototype. An oversize centrifugal compressor is employed, the excess delivery from which is bled off from the central casing of the engine surrounding the annular combustion chamber; pure air is extracted, heated only by compression and untainted by any combustion products.

At the point of delivery from the engine the extracted air has a pressure of about 41 lb/sq in gauge at maximum r.p.m. of 35,000. It would, of course, have been quite possible so to design the rotor as to obtain sufficient tip drive from this airflow alone. In the French S.N.C.A.S.O. Djinn, the nearest equivalent to the Fairey helicopter, this is in fact the case, the rotor producing something like 100 horse-power at maximum power using air alone. Previously (with the various types of Ariel helicopter) S.N.C.A.S.O. had attempted to inject fuel into airjets at the tips of the rotor blades and thereby increase the total rotor horse-power. This line of development was, however, abandoned several years ago, partly on account of excessive noise but, we believe, chiefly owing to difficulties experienced in metering the air and fuel flows along the rotor blades, and in obtaining efficient propulsive jets.

Undeterred by S.N.C.A.S.O.'s decision, the Fairey Company set out to employ tip-burning, using a weak mixture at the propulsive jets, thereby securing cooler running and reducing the noise problem and at the same time providing the aircraft with considerable development potential.

For the best all-round efficiency it would be desirable to have, at the tip of each blade, a propelling nozzle with an adjustable orifice, so that the cross-section of the jet could be decreased when operating on air alone. This arrangement is, in fact, somewhat impracticable, and in the Fairey helicopter the orifice size and the whole air system are designed to reach peak efficiency at maximum power. Operating conditions are, however, efficient and stable over a wide range of power, and the use of tip burning is not reflected in increased back pressure at the Palouste. Were the rotor to run on air only—i.e., without tip burning—a special nozzle would be required.

The actual control of power is obtained in the following manner. On the end of the collective-pitch lever is a conventional twist-grip throttle which, operating through the Palouste constant-speed unit, varies the engine r.p.m. and hence the air delivery and pressure. Movement of this throttle grip also turns a cam which operates control regulators for the tip-jet fuel supply.

The Palouste is started electrically and the air delivered bled to atmosphere through a discharge pipe immediately above the engine and under the control of a manually-operated blow-off valve. When the latter is closed the air is delivered through a large lagged supply-pipe leading to the rotor and thence through the rotor blades themselves to the propulsive jets at their tips. Fuel—kerosine, from the same tank as that which feeds the Palouste—is then fed to the rotor by a low-pressure pump, and metered at the head itself. Flow of fuel down the blade is, to some extent, discontinuous; but the droplets of fuel coalesce at the injection nozzles under the centrifugal load to form a continuous spray. The latter is then ignited by sparking plugs in the miniature combustion chambers. The life of the latter cannot yet be fully determined, but it is significant that all flying has so far been on one pair.

At full power some 250 gas horse-power are available from the Palouste, but the Fairey helicopter does not need anything like so much. Were the full potential power available to be employed, the maximum weight could be greatly increased and a multitude of jobs tackled.

Operation of the tip jets has been found to be as easily controlled and flexible as is that of the Palouste itself. Combustion can be sustained over a wide range of pressure ratios and mass flows. When power is reduced from the maximum value, the fuel supply to the tip jets is cut down at a proportionately greater rate so that the mixture strength is weakened for cruising flight. The pilot has a choice of engine speeds between 35,000 and 25,000 r.p.m., the latter corresponding to the flight-idling position. Even with the throttle twisted right down to the flight-idling stop, the tip jets remain alight. The rotor horse-power cannot, therefore, be reduced to zero in the air; but the power available at the flight-idling condition is less than that needed for level flight and the aircraft can therefore make normal descents at this setting. For really rapid descents, however, it is possible to open the blow-off valve and thereby cut off the supply of air to the rotor—thus, in effect, putting the machine into auto-rotation. Fully auto-rotative descents have not yet been carried out, but no difficulties are expected. Under development is a revised form of fuel regulator interlinked with the blow-off valve in order to provide single-level control of rotor horse-power from 100 per cent power down to zero.

In the design of the rotor, the great reserve of power available has enabled the Fairey designers to consider criteria other than pure performance in selecting the design parameters. The low diameter of 28ft has been made possible by operating at high r.p.m. and accepting a fairly low mean operating lift coefficient. The Djinn, on the other hand, has a rotor designed principally upon performance factors, with considerably greater diameter and operating C_L and, owing to the use of tip jets employing

(*Concluded on page* 592)

Principles of Gas Turbine Control

Current Methods and Trends Reviewed

By J. M. STEPHENSON

THE production of control components for jet engines and auxiliary gas turbines is a large industry in the United States. Frequently, too, the entire system-responsibility for control design and analysis of a new engine is undertaken by companies specializing in this field. This article outlines some of the principles which govern the choice of control system, and mentions some of the hardware which has been specially developed. Although the problem of control-loop stability is always present, it is not discussed because it can generally be solved during development, without penalizing engine performance.

A control system is fitted to an aircraft engine to reduce the work and worry of the pilot, and leave him free for other duties. It takes off his shoulders the routine of operating switches and levers in sequence, and of having to temper his commands to the engine by watching innumerable gauges. It is generally accepted that the pilot of a jet aircraft should have to move only one power lever, calibrated linearly in units of thrust, and the control system must then ensure that the engine:—

(1) Produces just as much thrust (relative to the maximum available at the particular altitude and Mach number of flight) as the pilot commands—and produces it steadily.
(2) Responds with alacrity to new commands.
(3) Is protected from damage, however erratic the commands.
(4) Runs with its best possible efficiency when thrust in the "cruising" range is selected.
(5) Produces the greatest allowable thrust, for the prevailing flight conditions, when "maximum" thrust is selected.

The simplest concept of such a control is shown in Fig. 1. A "feedback loop" is drawn in dashed line; without automatic feedback the control is merely an "open schedule" in which the accuracy of the output depends entirely on the calibration of the engine. The pilot himself must then act as the feedback, continually making corrections. As shown, the control tries to reduce to zero the error between the *sensed* thrust and the thrust commanded by the pilot. The accuracy of the control then depends chiefly on the accuracy of the thrust senser, and is not much affected by changes in the calibration of the engine.

However, methods of measuring thrust in flight have not yet been developed far enough to be worth using in a control; for it is no use holding the sensed thrust accurately if this does not correspond closely with the true thrust output of the engine. Therefore, other engine parameters are used for feedback, as will be discussed shortly.

Basic Schedules. The principal parameter which the engine control handles is the fuel flow into the combustion chambers. In addition, jet engines may have afterburners, with separate fuel controls, and variable-area propelling nozzles. A fourth quantity frequently has to be varied by the controls of single-spool engines: the pitch setting of the entry stator blades, which are set fine for starting and gradually opened during acceleration. Indeed, in some engines several of the compressor stages have variable-pitch stator rows.

If the pilot is still to be given only one lever, the thrust selector must schedule values of all four independent variables.

Analysis of the performance of a turbojet shows that the relations between the temperatures, pressures, shaft speeds, and fuel flow are unique only if expressed in non-dimensional or corrected form. Thus, as an aircraft changes altitude and Mach number with a fixed thrust lever setting, the fuel flow must be compensated for the changes in ram intake pressure and temperature—and also, in theory, for the inevitable variations in the heat content of the fuel and in combustion efficiency. Even then, constant values of corrected fuel flow and nozzle area will only hold given *ratios* of turbine temperature/ram temperature (Fig. 2), given *ratios* of shaft speed/$\sqrt{}$ (ram temperature), and so on.

Structural Limits. However, the life of the engine parts does not depend on these corrected parameters, but on the stresses to which the parts are subjected, which depend on the absolute values of shaft speeds and pressures. Also, the maximum allowable stress for any material falls off rapidly when the absolute temperature exceeds a critical level. Thus, the nozzle area and corrected fuel flow of a point on Fig. 2 which might safely be scheduled for subsonic cruising might cause damage by overheating of the turbine when the engine is flown at, say, Mach 2 at the same altitude. To protect the engine, therefore, the schedules called for by the thrust selector must be overridden when the turbine temperature or pressure, or the shaft speeds, exceed their allowable limits.

Much careful calculation and design is necessary to ensure that these overrides do not produce large "flat spots" on the thrust lever quadrant, at any of the required conditions of flight (Fig. 3). It is desirable to obtain a linear response to commands,

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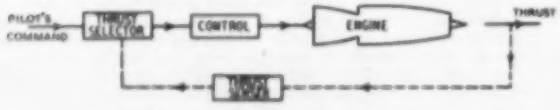

Fig. 1 (left). The simplest conception of a control system.

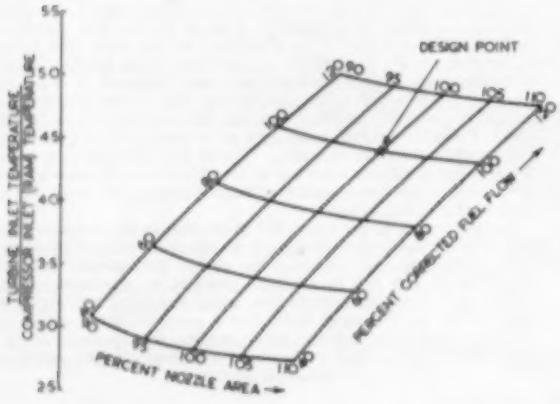
DESIGN POINT
TURBINE INLET TEMPERATURE / COMPRESSOR INLET TEMPERATURE
PERCENT NOZZLE AREA
PERCENT CORRECTED FUEL FLOW

Fig. 2 (lower left). Variation of engine temperature ratio with fuel flow and nozzle area.

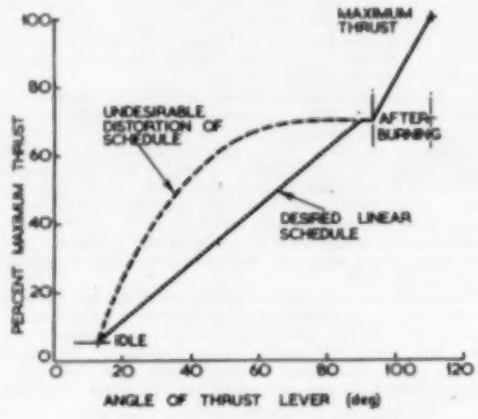

Fig. 3 (below). Thrust produced at command of thrust lever.

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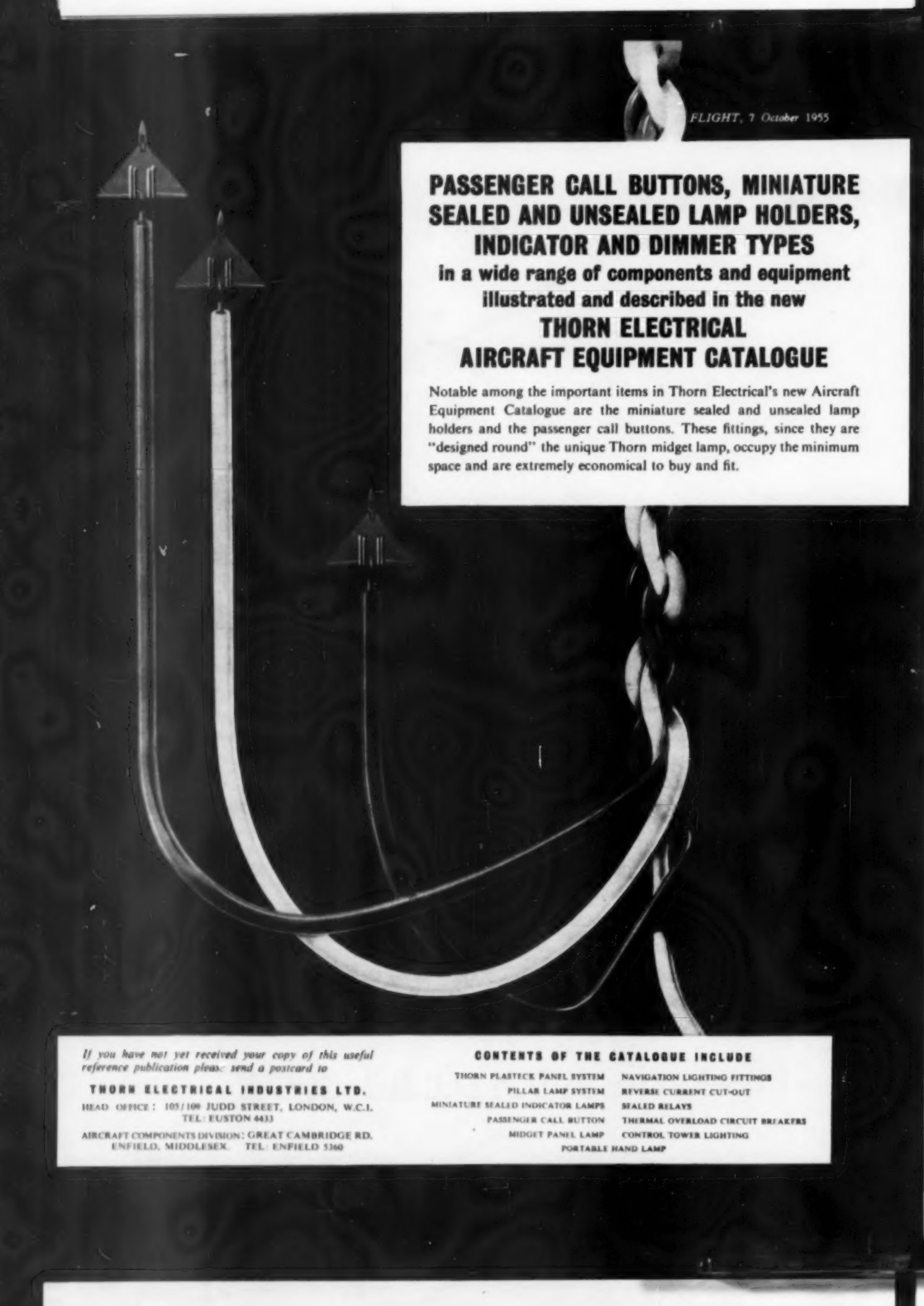

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PRINCIPLES OF GAS TURBINE CONTROL . . .

but usually this can be achieved at only one point in the flight spectrum—e.g. at sea level static, or cruise in the stratosphere.

Emergency Control. Understandably, all engine builders specify that if any part of the control system fails, the pilot must retain manual control of the engine. There are two different philosophies as to how this requirement may be met.

Some control designers have taken the view that, as so many flight and engine variables enter the performance problem, the engine can best be controlled by an elaborate computer, either electronic or mechanical. Unfortunately, engine-mounted equipment is subjected to such severe vibration and heating that the reliability of any computer, and particularly one containing electronic tubes, is likely to be poor. Consequently, a very simple fuel metering system must be added as a standby for "emergency" use. It might be foreseen that pilots would frequently be forced to switch off their control computers and fly home on manual. The cost of such an arrangement, both in terms of maintenance and of failed missions, is very high.

A preferable solution is to build the control around the simplest possible mechanical metering valve and nozzle positioning actuators, adding the various limiters, temperature sensers, and electronic equipment as trims. If any of these fails, the only damage done is that the pilot has to watch a gauge that would otherwise look after itself.

Main Fuel Control. The only really necessary part of a fuel flow control is a hole whose area is increased as the power lever is advanced. However, the fuel required by the engine is proportional to the ram intake pressure, which means that twenty times as much is required at Mach one at sea level, as at cruise at 50,000ft. It is asking too much of a pilot to take account of such a variation, so a basic "emergency" control must also include a diaphragm which changes the area of the hole with pressure according to the intake ram pressure level.

To obtain a more accurate control, this basic schedule must be trimmed with a feedback loop—and the engine parameter which can be sensed most accurately is the shaft speed. Hence, the almost universal use of a hydraulic all-speed governor, which keeps the shaft rotating at the rate scheduled by the thrust selector (Fig. 4). In this way, a measure of feedback control is

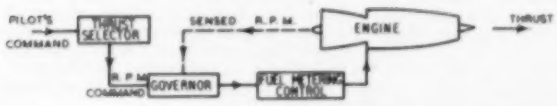

Fig. 4. ". . . the almost universal use of a hydraulic all-speed governor."

achieved, but the loop is a minor one, and does not include those characteristics of the engine which translate shaft-speed into thrust.

A further limitation of scheduling shaft speed directly is that, as already mentioned, "corrected speed" is a function of the ram temperature. To eliminate this discrepancy, there is now a growing trend towards biasing the all-speed governor with a gas or liquid-filled bulb ram-temperature senser. The overspeed limiter, however, must *not* be corrected.

Afterburner Fuel Flow Control. In the afterburner, as in a pure ramjet, there is no shaft speed to measure, and some alternative to the all-speed governor must be found for metering the fuel flow. Usually, the air-fuel ratio is scheduled by the thrust selector. If the main engine is always run at the same conditions when the afterburner is alight, the corrected air mass flow is constant, i.e., the true air mass flow is proportional to any of the pressures within the engine. So the afterburner fuel flow can be made proportional to, say, the compressor delivery pressure.

A minor feedback loop may be added, by so adjusting the fuel flow as to produce a constant pressure drop across a metering valve, but this will control only the *volume* flow, and not make allowances for what may be considerable changes in fuel density.

As a rule, it is thought desirable to include an automatic speed (or pressure ratio) switch in the fuel and ignition circuits, so that, if the pilot's lever is slammed all the way from idling to the afterburning range, the afterburner will not light up until the engine has come up to speed.

Nozzle Area Control. For engines without afterburners, fixed-area nozzles are fairly satisfactory. But when an afterburner is lit, the nozzle must open to as much as 50 per cent greater area if the flow conditions upstream are to be kept constant and the engine is to be prevented from surging. A typical schedule of nozzle area with thrust is sketched in Fig. 5. For the thrust range between idle and cruise, the shape of the area schedule is

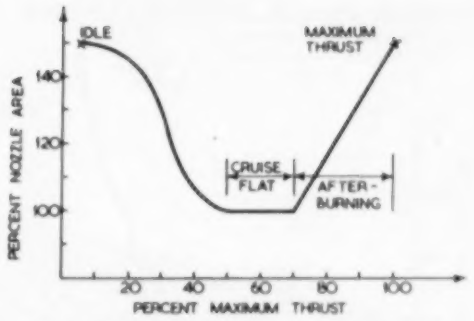

Fig. 5. A typical schedule of nozzle area with thrust.

not critical. However, acceleration can generally be made faster if the nozzle is held open at low thrust.

It might be thought attractive to modulate the final nozzle so as to control the turbine temperature at its greatest allowable level for all values of thrust in the afterburning range—for opening the nozzle with constant shaft speed (or constant fuel flow) causes the turbine temperature to fall, and *vice versa*. Unfortunately, temperature sensers so far developed take a few seconds to respond fully to changes, and are thus too slow to be used as direct controllers unless delays are introduced into the afterburner fuel system. To provide coarse motion of the nozzle actuators, two alternative parameters may be controlled:—

(i) Shaft speed, which rises as the nozzle is opened. This type of control is attractive for the low-pressure (inner) shaft of a two-spool engine, where an all-speed governor scheduling the fuel flow is fitted to the high-pressure (outer) shaft.

(ii) Turbine pressure ratio. So long as the propelling nozzle of a jet engine is choked, the pressure ratio across the turbine is proportional to the nozzle area, and independent of all other parameters, including the shaft speed. Thus, at least at the high end of the thrust range, turbine pressure ratio is an attractive parameter to control to a schedule by means of the nozzle.*

It is important to remember that neither of these control methods eliminates the need for a turbine temperature limiter, which must still be fitted to the fuel control, or, if more convenient, added as a trim to the "coarse" nozzle control.

Temperature Sensers. There still remains uncertainty among engine builders as to whether or not an accurate temperature controller or limiter can be made simple and reliable. The temperature in an engine is most critical at entry to the turbine, where it may reach 2,000 deg F. If this is too high to be measurable, the temperature of the gas leaving the turbine may be measured and controlled instead, since the two temperatures are approximately proportional.

Several different principles are being tried experimentally for temperature sensing, but only one type of senser is in common use: the Chromel-Alumel thermocouple, which produces a very small D.C. voltage proportional to the difference between the measured temperature and some datum. This signal must be amplified if it is to do any work. To avoid the inevitable drift of electronic amplifiers, a mechanical chopper is generally used, to turn the signal into A.C.—though the system then suffers from stray interference. †

Another type of turbine temperature senser consists of a sealed bulb filled with mercury. The rapid increase of mercury vapour pressure in the temperature range of interest is used to actuate the control, either through a direct mechanical linkage to an electrical or hydraulic servo, or by bleeding air from a pneumatic servo.

The temperature of the gas is rarely uniform over any given cross-section of an engine, and it is wise to average the signals from at least four sensers. The same thermocouples may be used to provide both cockpit indication and temperature control, but it usually is thought safer to use separate sets, if necessary by inserting two sets of leads into each probe.

Acceleration Control. When an engine is accelerated by increasing the fuel flow, the turbine temperature rises more rapidly than the shaft speed, and must be prevented from exceeding the allowable limit. In addition, the compressor moves nearer the surge region of operation (except in the case of the low-pressure compressor of a two-spool engine). Thus for any position of the thrust selector lever, there is a value of the corrected fuel flow which corresponds to steady running, and a

**This is the principle of the Solar "Microjet," which, it was recently announced, Bristol are to employ for their Olympus afterburners.*

†Direct input to a magnetic amplifier is satisfactory in a simple temperature limiter; but the resolution of such an arrangement is not adequate for a proportional control.

PRINCIPLES OF GAS TURBINE CONTROL . . .

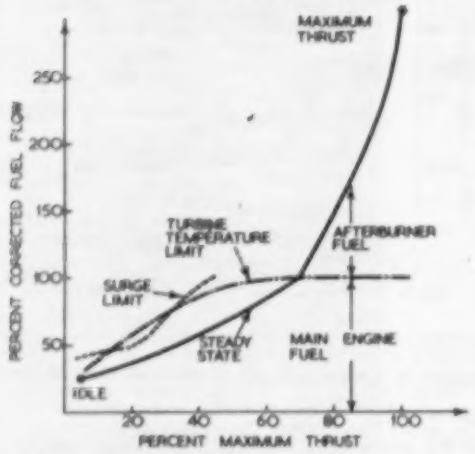

Fig. 6. Typical requirements of fuel flow for various conditions.

higher value which cannot be exceeded without causing overheating, or compressor surging (Fig. 6).

Also, in many engines, there is a lower limit to the corrected fuel flow, below which the flame in the combustion zone may be blown out.

The most common way of approaching the upper limit so as to obtain the fastest possible acceleration is to set up a schedule of fuel flow versus shaft speed, which may not be exceeded. This schedule must, of course, be corrected for both ram temperature and pressure. As the exact shape of the limit line cannot, with present design techniques, be predicted with sufficient certainty, the schedule must be determined during engine tests.

Another solution of the problem is to schedule the limiting fuel flow only roughly, and to use a feedback control to trim down the flow to a more accurate schedule. This method can be simplified by two design features of the fuel system: first, as the pumps are driven by the engine (or by compressed air from the engine), the greatest flow they can deliver increases with engine shaft speed. Next: the metering valve that varies the fuel flow with engine pressure level can be made to depend on compressor delivery—rather than entry—pressure, making the maximum available fuel flow even more strongly proportional to engine speed.

For trimming the fuel flow to an accurate acceleration schedule, a signal must be fed in, which is a measure of the difference between the actual value of some engine parameter, and the value corresponding to surge of the compressor. Several parameters may be used: compression ratio, compressor temperature rise, or mass flow, the choice depending largely on the application. Yet another parameter which may be limited is the angular acceleration of the shaft, and this type of control is, for some engines, the most attractive of all.

The chief disadvantage of all these scheduling methods is that even when the schedule has been set up experimentally, large variations are liable to appear between individual engine builds. An ideal acceleration control would therefore sense incipient surge in the compressor, as well as over-temperature in the turbine, and control the acceleration *via* a closed loop.

Limitations on Materials. It is today quite widely appreciated that the flight speeds now within reach produce very high ram air temperatures. Even at a flight Mach number of 2 in the stratosphere, the ram air temperature exceeds the boiling point of water, and any higher temperatures approach the limiting region where organic materials break down. This means that, unless extensive cooling is applied to engine accessories, no electronic or electrical controls can be used on very high-speed aircraft. Neither can hydraulic positioning actuators, using lubricating oil supply, be retained. Indeed, one is forced to attempt the whole control job with few materials beyond stainless steel and air.

For this reason, much work is being devoted to producing all-pneumatic systems, using the engine compressor as a source of air (5 to 15 atmospheres) to actuate the nozzle, and to trimming the pneumatic circuit with mercury probes to limit engine temperature.

Possible Extensions of Control Systems. The control principles described above treat the engine as a self-contained system, and still leave to the pilot the job of calculating the best altitude and speed for each flight, and of continually adjusting the thrust selector to obtain these. The only way in which flight conditions are taken into account is that an engine control intended for supersonic aircraft generally includes a pressure-ratio device which measures flight Mach number, and limits it to a preset safe value by over-riding either the main or the afterburner fuel flow schedule.

For many aircraft duties, it would be attractive to extend the control system so that it could accept commands, not of engine shaft speed, or even of thrust, but of the components of aircraft velocity—true air-speed vector, and rate of climb. The final step is then to store a pre-computed flight plan into a memory device, which issues commands to both the engine control and the autopilot in proper sequence. Such an arrangement is already used, in elementary form, in missiles.

ARMY HANDMAID (*continued from page 589*)

air only, has a rather lower optimum tip speed. Were the Fairey designers to choose a larger rotor or a design with a lower tip speed, it would probably be possible to fly on less power, but the present arrangement has certain singular advantages. It is obviously compact and readily transportable and blade sailing has been found non-existent in winds up to 25 knots.

Another advantage of the small size of the rotor is that it has made possible considerable simplification in mechanical design. No drag-hinges are employed and the two blades form a see-saw combination without individual flapping hinges (each blade can be removed with the aid of a ring spanner). It has also been found possible to employ a direct tilting-head type of control, the system adopted being carefully designed to obtain both rotor stability and the correct feel. Small bob-weights are fitted at 90 deg to the axes of the blades to improve stability at the expense of a slight increase in the loads on the cyclic-pitch lever. Flight trials have so far indicated that the machine is easy to fly, there being no undue loads transmitted to the pilot and the general level of vibration being low.

It is unfortunate that mechanical details of the most interesting parts of the aircraft may not yet be published. It is apparent, however, that the leading portion of each blade is a drawn steel tube which not only carries all the principal rotor loads but also forms the air duct. The remainder of the blade is a simple structure formed from thin light-alloy sheet.

At present the prototypes are flying with directional and yawing control provided by a simple steel-skinned rudder mounted behind the efflux from the Palouste. Tunnel results suggested that it would be advisable to employ a tailplane and additional fins and some flying has in fact been carried out with a tailplane in place. The structure has in any case been designed to take a fixed tailplane and fixed fins if longitudinal and directional stability should require such surfaces.

The basic structure could hardly be simpler. The basis of the helicopter is a large light-alloy box containing a bag-type fuel tank. From the centre of this box rises a curved box-section pylon to which is attached the rotor and from which the remainder of the helicopter is hung. To the rear is attached the simple light-alloy box-girder boom carrying the rudder. This boom is split in the centre by a bolted transport joint and the Palouste powerplant is slung from the forward fixed portion.

The landing gear consists of a pair of simple skids formed from light-alloy sheet with a wood filling. These are attached to a pair of light-alloy tubes which run across the underside of the nacelle, to which they are attached rigidly on the aircraft centre-line. Vertical "springing" is provided simply by the upward deflection of the cross-tubes. The cockpit, while not being in any sense cramped, is probably the minimum envelope for a crew of two. Provision is fitted for dual controls, although in the A.O.P. rôle the observer would face aft. Comprehensive instrumentation is provided and racking is fitted for an Army radio set, although a V.H.F. transmitter/receiver is at present employed for prototype flying.

Faireys are very proud of the fact that the first prototype was airborne in August of this year, barely thirteen months after the start of design. Much of the constructional work of the prototypes has been done at the company's main factory at Hayes, but assembly and test-flying is being carried out at White Waltham, Berks.

The pressure-jet concept was formulated by Capt. A. G. Forsyth, chief helicopter engineer; the design of the Ultra-light has been directed by Dr. G. S. Hislop, chief designer (helicopters), and Mr. R. L. Lickley, Fairey chief engineer. The test flying has been in the hands of S/L. W. R. Gellatly, A.F.C., senior helicopter test pilot.

NOTE TO AIRCREW.

This test was carried out with a standard Mark 3 Ejection Seat fitted with a modified Time Release which is not yet incorporated in Service equipment.

On the 3rd September, Squadron Leader J. S. Fifield, D.F.C., A.F.C., was ejected from a Meteor Mark 7 whilst taking off from the runway at Chalgrove Airfield, Oxon. This is the first time in the history of world aviation that this feat has been performed, and no other ejector seat in the world can compare with this performance. This marks a red letter day in the history of escape from aircraft at ground level.

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THE AERONAUTICAL BOOKSHELF

"Great Airmen," by W/C. Norman Macmillan, M.C., A.F.C. G. Bell and Sons, Ltd., York House, Portugal Street, London, W.C.2. Illustrated. Price 12s 6d.

RANGING from the Wright brothers flying at 30 m.p.h. to American test pilots reaching speeds of over 1,000 m.p.h., this book gives some informative details about well-known aviation pioneers, fighter pilots and test pilots of various nationalities. W/C. Macmillan has taken trouble to treat his subject thoroughly, balancing particulars of heights and speeds achieved by aircraft with personal details and anecdotes of the men identified with them. Simply written, it should appeal to readers of all ages.

"Collected Papers on Aviation Medicine," Agardograph No. 6. Published on behalf of the Advisory Group for Aeronautical Research and Development, NATO, by Butterworths Scientific Publications, 88 Kingsway, London, W.C.2. Illustrated. Price 37s 6d.

THIS is a collection of the papers presented at Aeromedical Panel meetings of A.G.A.R.D., the NATO aeronautical research body. Eighteen papers are reproduced, four of them in French, the rest in English, dealing with a variety of aviation medicine topics, from methods of selecting suitable aircrew recruits to factors governing the resistance of the human body to various acute stresses.

Particular attention has been paid to cockpit layouts, and to the relationship which must exist in this connection between the medical research worker and the technical design engineer. The effects of cold and extreme climatic conditions and their effect on survival of aircrew are the subject of several papers.

The collective publication of these treatises offers an excellent work of reference for those concerned with, or interested in, aviation medicine.

"Civil Defence" (History of the Second World War), by T. H. O'Brien. H.M. Stationery Office, Atlantic House, Holborn Viaduct, London, E.C.1. Price 37s 6d.

IN the Stationery Office series dealing with the history of the Second World War, this volume presents a most detailed and instructive picture of all the aspects of Civil Defence—"a new form of national defence" evolved slowly between the two World Wars to counter heavy air attacks. It shows how air raid precautions were based on the two principles of harnessing this defence to the machinery of local authorities and of inviting all sections of the community to play their part in sharing the burden. The early, small-scale air raids of the war were followed by the building-up of further defences in the months of respite from late 1939 until the spring of 1940. Regional organization, training, equipment, the National Fire Service, and types of shelter, are all discussed in great detail, and the final chapter traces the plans and efforts made to meet the challenge of the V-weapons used in the last year of the war. A pleasing point about this very comprehensive book is the lucid prose employed throughout; official jargon is very largely avoided.

"British Civil Aviation," by D. G. T. Harvey. Adlard Coles Ltd., Southampton, in association with George G. Harrap and Co., Ltd., 182 High Holborn, London, W.C.1. Illustrated. Price 15s.

PART 1 of this pocket-sized handbook contains photographs, general arrangement drawings, specifications and other data of all aircraft flown by British airlines, together with notes on future projects. Part 2 presents directory-style particulars of the history, executives, routes, fleet and some statistics of British operating companies.

The whole thing is printed on art paper and, within its limitations, is quite attractive and informative. Chief criticism is that the standard of the G.A. drawings ranges from adequate to deplorable. There is no consistency. In some cases the plan drawing shows an underneath view; in other cases a top view. Airscrews are shown variously as discs, blades, dotted lines or not at all. Scales are not always the same in all three views of a single type.

Nor has the data been cross-checked satisfactorily. Silver City are credited with 16 Bristol 170s on page 59 and only 15 on page 157. The Princess has up to 200 seats on page 103 and 220 on page 126. Reference is made to the closing of Lympne in column 2 on page 157, yet services from Lympne are listed in column 3. Other errors include the persistent mis-spelling "Sikorski," and reference to the Leonides Major as the standard engine of the Westland S-55.

Such faults should not exist in so small a book priced at fifteen shillings.

"Squadron Airborne," by Elleston Trevor. William Heinemann Ltd., 99 Great Russell Street, London, W.C.1. Price 13s 6d.

NO book that we have read in recent years has brought back such vivid, tragically-proud memories of the Battle of Britain as this novel by Elleston Trevor. The story itself is superb: but it is the almost uncanny accuracy of detail that makes it live for those who had half-forgotten such sights as a row of human "mobile sandbags" lying on the tailplane of a Spitfire while its engine was run up, or sounds like the "ticking" of the Merlin as it cooled and contracted.

That such a book has come from an author who claims no close association with Fighter Command in 1940 reflects the vast amount of care and research that must have gone into it. The theme is no different from that of dozens of lesser novels—just an account of life, and death, in a single squadron at a fictitious airfield in Southern England over a period of a single week in that grim summer.

There are the usual calm, capable squadron leader; the worn-out veteran of Dunkirk breaking up under the strain of endless combat against odds; the new boy who must, inevitably, make good; an over-amorous Waaf. But these characters are different. They are real, just as all the things that happen to them are real; and the reader understands every facet of their many-sided characters because for 254 pages he lives with them, sharing their thoughts, fears and desires.

Perhaps, more than anything else, *Squadron Airborne* rings true because it underlines the great contribution to victory made by the ground crews—men like L.A/C. Cornelius, for whom an enemy raid on the airfield was nothing like so worrying as the fact that one of the squadron's all-too-few Spitfires needed a new air-compressor to make it serviceable. In every way, this book is worthy of "The Few" to whom it is dedicated.

"Canada's Flying Heritage," by Frank H. Ellis. University of Toronto Press. Obtainable from Oxford University Press, Amen House, Warwick Square, London, E.C.4. Illustrated. Price 63s.

WRITTEN by one of Canada's best-known "early birds," this is a superb record of that country's contribution to the history of aviation, in 388 pages and hundreds of illustrations.

It begins with the story of the Aerial Experiment Association, founded in 1907 by the great Canadian inventor, Dr. Alexander Graham Bell, and which first gave scope to the design genius of the American Glenn Curtiss. The *June Bug*, built by the A.E.A. to Curtiss's design, made the first official one-kilometre flight recorded in the Western Hemisphere and so won the *Scientific American* Trophy in 1908. More important, it led to the whole series of later successful Curtiss designs.

It was followed by the *Silver Dart*, credited to Canadian John McCurdy who, on February 23, 1909, made in it the first official controlled aeroplane flight by a British subject anywhere in the Empire, by flying more than half a mile over the frozen surface of Bras d'Or Lake, Baddeck, Nova Scotia. Six months later it was demonstrated to the Canadian Army at Petawawa military camp, near Ottawa, without convincing them of its usefulness.

But the growing reliability and promise of aviation could not be overlooked for long in a country such as Canada, where surface travel is difficult or even impossible for much of the year in remote northern districts.

The 1914-18 War led to the start of the country's aircraft industry; and, soon after the Armistice, airmen (among them Frank Ellis himself) began making survey flights into the far north. Before long the term "bush flying" had been added to the language of flight. More than that, its peculiar demands had a tremendous influence on aviation progress in the Dominion, calling for successive generations of tough, highly skilled pilots and rugged, reliable aircraft, from the Fokkers and Fairchilds of the twenties and thirties to the Beaver and Otter of today.

Inevitably, there is much about bush flying in this book, and it makes first-class reading. The illustrations leave little doubt of either its hazards or its value, and the variety of jobs undertaken will surprise most readers. One picture, dating from the days before specialized freight-planes existed, shows how horses were flown on bush services—doped, on large wooden stretchers!

Many of the great names of aviation appear in the pages of *Canada's Flying Heritage*. In the early days, pioneers like Glenn Martin and Bill Boeing, and stunt men like Lincoln Beachey, flew over the border to cash in on growing Canadian air-mindedness. Later, the Dominion (and Newfoundland) became stepping stones for great flights by Alcock and Brown, Wiley Post, Lindbergh, Amelia Earhart, Hinkler, Mollison and a host of others.

But the real value of this book is that it records the work of hundreds of lesser-known men and women, who would probably

THE AERONAUTICAL BOOKSHELF . . .

have been forgotten in another ten years. There are priceless pictures of early projects like "Alberta's Flying Saucer" of 1907 and the Gibson and Pepper aircraft of the stick-and-string era. Philatelists will delight to see a selection of stamps and covers illustrating air mail progress in the Dominion. And there is a series of extremely valuable appendices giving everything from a chronology of outstanding events in Canadian flying history since 1879 to portraits and details of winners of the McKee Trophy, the country's highest aviation award, a list of pupils of the old Curtiss school at Toronto, and notes on national aviation cairns and monuments.

"'The Aeroplane' Directory of British Aviation, 1955." Temple Press Ltd. Bowling Green Lane, London, E.C.1. Price 21s.

COMPILING a directory is rather like painting the Forth Bridge: the work is no sooner completed than one has to dash back to the other end and start again. To make matters worse, this particular "bridge"—British aviation—gets steadily bigger each year. As a result, the current edition of this directory is larger than ever.

The mixture is as before, with efficient general and "trade names" indices and thumb-tab guide cards, which greatly speed up location of particular items of information. Only possible criticism of what has become an indispensible annual is the continued practice of intermingling advertisements with the reference pages. This was, presumably, adopted for commercial reasons; but is less welcome to the general reader than the pre-1953 layout, with all "ads" together at the front and back of the book.

"Flying For You," by John Gunn. Lutterworth Press, 4 Bouverie Street, London, E.C.4. Illustrated. Price 12s 6d.

EX-NAVAL pilot John Gunn describes how aeroplanes are built, why they fly and how they are flown, in a book full of Australian good humour and down-to-earth common-sense. Intended mainly for youngsters, it gives also a great deal of useful information on careers in the Fleet Air Arm and R.A.F., with the airlines, as a test pilot and in the industry.

Most important is that the book is bang up-to-date, with even a chapter on vertical take-off aircraft, in which the author rejects the current crop of tail-sitters and "bedsteads" in favour of "aircraft with jet-engines that blow a high-velocity stream of air over a lifting surface . . . possibly . . . even a flying saucer." Such references to exciting pioneer work still to be done are just the thing to attract the right kind of youngsters into aviation at a time when they might see little future in it, because of constant references in the misguided press to the imminent replacement of piloted warplanes by guided weapons. Nor are they likely to be deterred by an excellent account of all the toil, sweat and tears that go into the design and development of a new aeroplane.

There is no "padding" in *Flying For You*, and most of the illustrations have been chosen because they contribute to the purpose of the story, and not merely because they are pretty pictures. They include everything from line diagrams explaining the theory of flight to photographs of cloud formations, mirror landing aids for aircraft carriers and the annotated cockpit of a Vampire Trainer. A satisfyingly large number include parties of boys inspecting a Viscount, learning to fly gliders and under training at Henlow, Halton and the Navy's university of engineering at Manadon, near Plymouth.

OTHER BOOKS RECEIVED

The First and the Last, by Adolf Galland (translated by Mervyn Savill). Methuen and Co., Ltd., 36 Essex Street, London, W.C.2. Price 18s.

Spontaneous Ignition of Liquid Fuels, by B. P. Mullins, Ph.D. Butterworth's Scientific Publications, 88 Kingsway, London, W.C.2. Price 20s.

Under Six Planets, by Winifred Brown. Peter Davies, Ltd., 38 Bedford Square, London, W.C.1. Price 15s.

Technical Publications—Their Purpose, Preparation and Production, by C. Baker, A.R.Ae.S. Chapman and Hall, 37 Essex Street, London, W.C.2. Price 36s.

The Navigator, by Jules Roy, Turnstile Press, Ltd., 10 Great Turnstile, London, W.C.1. Price 8s. 6d.

Die 2. Etappe, Die Geschichte der Flugzeugturbine und des Turbinenflugzeuges, by C. Walther Vogelsang.

Morale in War and Work, by T. T. Paterson, M.A., Ph.D., R.A.F. (Retd.), Max Parrish and Co., Ltd., 55, Queen Anne Street, London, W.1. Price 18s.

Combustion Researches and Reviews, 1955, Agardograph 9. Butterworth's Scientific Publications, 88, Kingsway, London, W.C.2. Price 35s.

Lion with Blue Wings, by Ronald Seth. Victor Gollancz, Ltd., 14, Henrietta Street, Covent Garden, London, W.C.2. Price 16s.

Wings, by Blanche Stillson. Victor Gollancz, Ltd., 14, Henrietta Street, London, W.C.2. Price 16s.

Technical Aerodynamics, Third Edition, by Karl D. Wood. Published by the author, distributed by Ulrich's Book Store, Ann Arbor, Michigan, U.S.A.

HELICOPTER "FLOAT" PLATFORM

SHOWN in the accompanying photograph is a roof-top helicopter landing platform designed by Alan C. Thomson and developed by his firm, the Thomson Research Co. (Mr. Thomson is also manager of the Mesa division of the American helicopter division of the Fairchild Corporation). The new platform utilizes a hydrostatic water cushion to distribute first the landing load and then the stationary weight of the helicopter evenly over a wide area—i.e., the area of the whole platform. The landing pad, which is of aluminium honeycomb construction, weighs only 5 lb/sq ft and floats on two inches of water contained in the large "tray." The pad fits closely to the retaining walls and there is only very slight vertical motion when the aircraft lands. Apparently there is no tendency for water to be expelled.

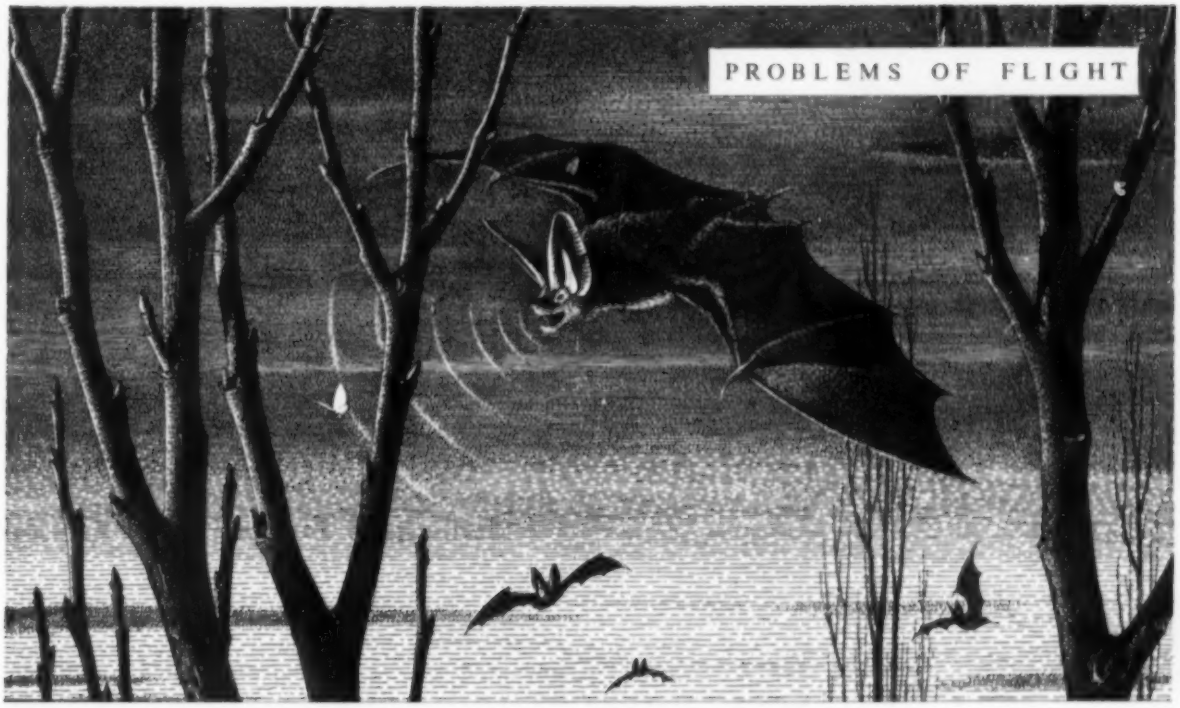
Installation of the "Heli-Float," as the device is called, is claimed to be a simple operation, especially as the pad is made up of a number of easily detachable rectangular sections.

Mr. Alan C. Thomson and his "Heli-Float" (see column 1).

"FLIGHT" PHOTOGRAPHS

MANY of the photographs reproduced in *Flight*, i.e., those taken by our own photographic staff (as indicated on publication) are subsequently available in the form of high-quality prints. Prices are as follows (dimensions given in inches): 5½ × 3½, 1s 4d (glossy or semi-matt, unmounted) or 2s (toned sepia, unmounted); 6 × 4, 2s 6d or 4s; 8 × 6, 3s 6d or 5s 6d; 10 × 8, 5s or 7s 10d; 12 × 10, 6s or 9s 8d; 15 × 12, 9s 6d or 13s; 20 × 16 (semi-matt only), 13s or 18s.

Also available are a postcard series, totalling over 200, depicting both historic and modern aircraft of the R.F.C., R.N.A.S., R.A.F. and Fleet Air Arm. Complete lists of the series are obtainable on application. Prices are 8d each card, or 7½d each for quantities of a dozen or more. One view only—in most cases a good three-quarter front or side—is available for each aircraft type. Also available as postcards, at the same prices, are reproductions of general-arrangement drawings of some 20 British aircraft that have appeared in our "Aircraft Intelligence" pages.

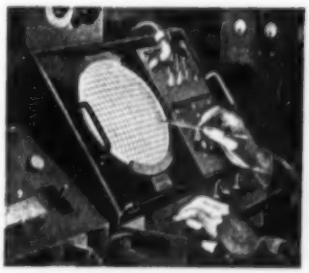


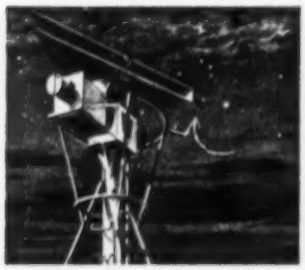
ECHO-LOCATION

THE technique of detecting invisibly-distant objects by reflected waves of impulses was an important factor in winning the war. It is now vital to the defence of the West, and of immense value to civil aviation. Radar is the latest of the various techniques of detection by reflection — but by no means the only one. The most ancient is the echo-location of the bat.

There are over two thousand species of bat. Some are carnivorous, one a vampire, some fruit-eating, and many live on insects. These last (including the British species) catch tiny flies and midges on the wing, darting erratically about as they hunt, but avoiding obstacles with uncanny precision even in darkness. Recently a bat was blindfolded: it still steered rapidly and accurately. But when its ears were covered it blundered helplessly into plainly-visible obstacles. The bat's technique of echo-location — proved by this experiment — is made possible by a remarkable development of special equipment. It emits a succession of bursts of supersonic vibrations from its larynx. These are at a frequency of around 50,000 per second. The bat's large ears pick up the echoes of these supersonic calls and by some almost incredibly rapid and exact mechanism inform the bat accurately about its surroundings. Its brain is developed to translate this information — which must be very complicated if the bat is flying in a crowded space — into instant action. If a crew laying a gun on the information of a radar-screen could achieve anything like the bat's speed and accuracy, anti-aircraft defences would be quite impenetrable.

Radar is becoming more and more important





in an offensive role, too: its powers of detection even in thick darkness make it invaluable to an interceptor. For this also the bat provides a precedent. His technique of echo-location is apparently so sensitive that he can detect with it even the tiny fast-flying midges he feeds on. If, again, we can ever begin to match with our radar the bat's efficiency, our interceptors will be formidable indeed.

The radar of a modern aircraft and the echo-location of the pre-historic bat are very different. But the techniques are comparable — and above all the purpose is the same. Here is yet another example of Nature anticipating, by thousands of ages, man's most revolutionary inventions.

Pilots who land their aircraft, by sight or sound, at airfields all over Britain have come to value the help and efficiency of Shell and BP Aviation Service.

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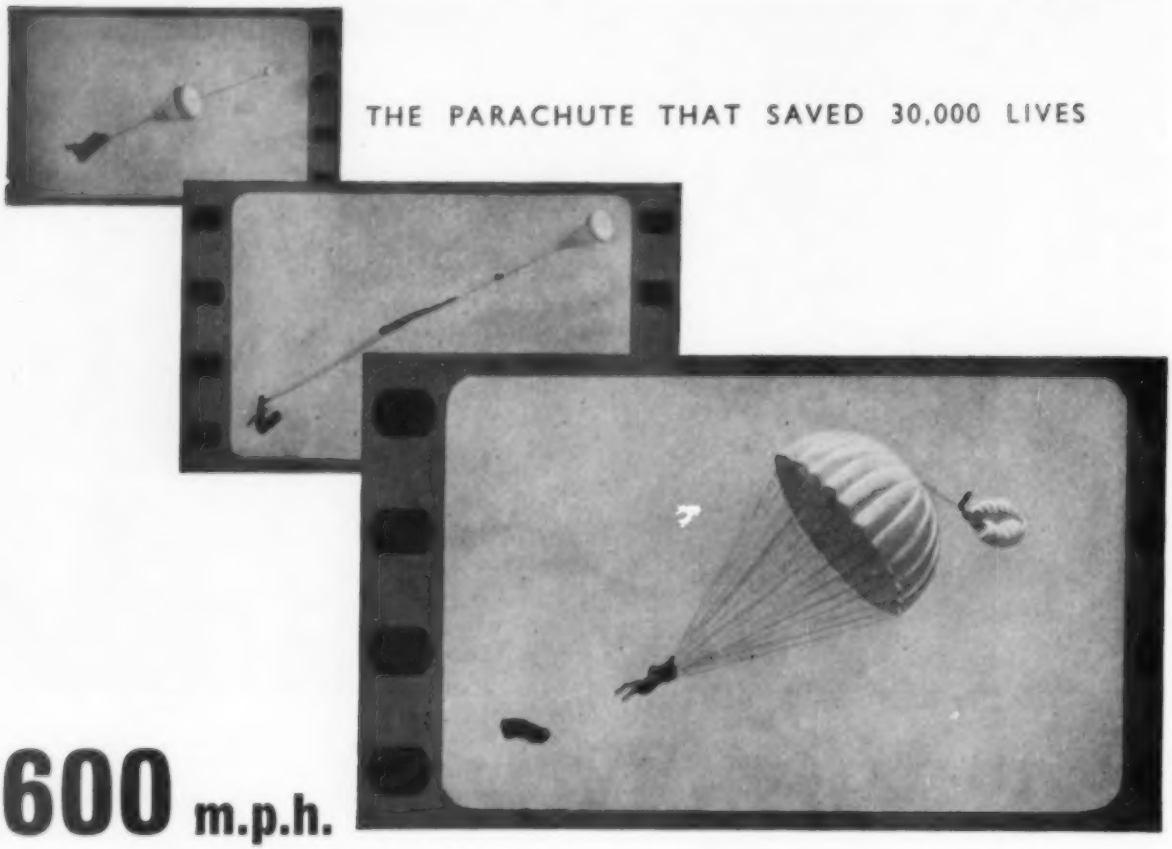

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600 m.p.h.

at ~~150 feet~~ *50 feet*

—still the safest parachute

In a ~~recent~~ *more recent* test of a Martin-Baker Patent fully Automatic Ejection Seat, an ejection was made from a Meteor 7 aircraft in straight level flight at 600 m.p.h. and only ~~150~~ 50 feet up. Three seconds after ejection this IRVIN 24-feet parachute was fully deployed before alighting. It was this same canopy design that saved the lives of 30,000 airmen during the war.

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CORRESPONDENCE

The Editor of "Flight" does not hold himself responsible for the views expressed by correspondents in these columns; the names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

Showing the Flag

RECENTLY, in Australia, we have been able to witness a number of very impressive demonstrations of American air power. The most recent example has been the non-stop flight by four Thunderjets from Tokyo to Newcastle. However, it has been only within the past few days that we have been able to see a much more potent weapon, contributed by the R.A.F.—the visit to this country by a Valiant.

I was privileged to see this aircraft land at Kingsford-Smith airport and to speak with some of the crew. The general appearance of the aircraft, together with the surprising quietness of the engines and the short landing run (it used about half of the 8,000ft instrument runway) caused much comment in the public enclosure.

This brings me to my main point. Although we have frequent goodwill missions from the U.S.A.F., whom we always welcome, we hear nothing from Britain. We do not of course expect visits from Hunters or Javelins (although we hope that, when these aircraft are eventually stationed in the Far East, we shall have an opportunity of seeing them), but we hope that the other V-bombers and the R.A.F. Comets will demonstrate in the Australian capitals. A visit by one of the Royal Navy's fleet carriers would also be appreciated, as many here think that the U.S.S. *Tarawa* represents the latest and best.

I am sure that all those who witnessed the arrival of the Valiant will join with me in saying "Congratulations R.A.F., and let's see some more of you."

Sydney, N.S.W. MALCOLM M. LAWRIE.

Russian History

IN your correspondence column in *Flight* of September 9th, Mr. J. P. Alexander wonders what became of Moshaiski's aircraft after its first flight. A few weeks ago I received, *via* Eastern Germany, the volume *Aviation* of the *Great Soviet Encyclopædia*. This volume is quite interesting and it tells a lot on Russian aviation history. According to the *Great Soviet Encyclopædia*, the first flight with Moshaiski's aircraft was made in July 1882 by Mr. I. N. Golubev. During the first flight, a speed of 40 km/hr was reached. During the landing the wing was damaged and the pilot injured. Probably no other flight was made with this vehicle. The *Great Soviet Encyclopædia* even publishes some drawings on Moshaiski's aircraft, but they are rather bad.

According to the Soviet book, everything in aviation was a Russian "first," i.e., the first balloon, the first aviation magazine, the first automatic pilot, the first parachute, the first airship, the first helicopter, the first seaplane, the first carrier and the first jet. . . .

Boskoop, Holland. HUGO HOOFTMAN.

DEWline Carriers

YOUR August 26th edition of *Flight* included an article on the DEWline operation in Northern Canada. For the sake of accuracy I would like to add that Canadian Pacific Air Lines is currently operating C-46 aircraft on this freight haul, in addition to the DC-3s mentioned in your article.

Seven of these aircraft, equipped as freighters and purchased primarily for the DEWline operation, are at present freighting between Norman Wells, Fort Nelson and the Arctic radar sites.

Edmonton, Alberta. J. ANDERTON,
Canadian Pacific Airlines.

Cody—a Question Answered

IN the correspondence page of *Flight* for September 16th, S/L. L. J. Bayliss mentioned "Cody's Tree" and asked if there was any record of the thrust of the pioneer's aeroplane.

S. F. Cody was waiting for months before he finally received permission to install the 50 h.p. Antoinette motor from the dismantled airship *Nulli Secundus I* in his aeroplane.

Meanwhile he used the tree to find out the sizes, shapes, and positions of his control surfaces. To do this he tied his front wheel, by means of a longish rope, to the back of the tree, facing into a fairly strong breeze. By depressing the front elevator he was able to lift his rear wheel from the ground and was then balanced on the narrow track of his main undercarriage wheels, enabling him to test wing warping, rudder control, etc., while stationary on the ground.

When he finally installed the engine, he used two metal propellers, the pitch of which could be varied by loosening and tightening bolts. He spent many weeks experimenting to find out the best angle, using a string and chalk marks on the floor of the airship shed, to measure the theoretical forward movement of the blade in one revolution. Then he tethered the back of his aeroplane to the front of the tree, this time using a rope and spring balance registering up to one-ton pull. (This balance was made by W. T. Avery and is still used by Mr. Vivian Cody at Ash Vale.)

Again he faced a south-westerly wind, because, in order to minimize friction, and a false reading, he depressed his elevator to raise the tail wheel, using additional ropes in front, screw-picketed to prevent the machine being blown backward into the tree; these had a certain amount of slack.

Every day he opened up his engine, and carried out endless experiments to find out the best angle giving the greatest thrust.

The interminable waiting was the probable cause of much of the abuse to which he was subjected, but he persevered patiently until he found the best angle, which gave a thrust of about 350 lb and soon afterwards made the first flight in England.

Describing this to the Aeronautical Society in 1908, he said: "I went out after adjusting my propellers at eight feet pitch, running at 600 revolutions per minute. . . ."

Virginia Water, Surrey. G. A. BROOMFIELD.

Camera Ban

HAVING read *Flight* for many years, may I now express a sentiment through your columns? Each year we look forward as a family to the R.A.F. "at home." Having been intimately connected with aviation in the past, it now remains our only chance to see aircraft at close quarters and look upon it as our own "Farnborough"—Yorkshirewise, I mean.

We thank the R.A.F. for a good show; but our pictorial record of aviation, which stopped rather suddenly with the closing of some reserve schools, cannot now be furthered—because, for some extraordinary reason, we are not allowed to take photographs. Why? Authority, please answer.

My growing boys particularly deprecate this as my own photographic record goes back to the 1914-18 war and now has an increasing gap.

Malby, Rotherham, Yorks. E. G. LAWRENCE.

Farnborough Complainant

AT 10 a.m. on Friday, September 9th, I paid £2 for myself and car to enter the S.B.A.C. Show. I was directed to park on the reverse slope of a steep hill just east of the Spinney: my car was uncomfortably tilted and I could see nothing of the aerodrome. I was annoyed, and at least one of my fellow-parkers was annoyed, at this treatment. We went together to Autoparks, Ltd., to complain, but found no one in authority. I have since written to the firm and sent a copy of my letter to the S.B.A.C.

On this expensive Friday my fellow-complainant and I expected to be parked where we could see the aerodrome and, if we so desired, watch the flying, from take-off to touch-down, surrounded by the comfort of our homes-from-home.

Is this an unreasonable expectation? Were there only two dissatisfied people present on September 9th?

Haslemere, Surrey. P. H. W. RUSSELL.

Stratoliners—Data Corrections

IN spite of the very considerable volume of data research undertaken by me in connection with *The Veteran Stratoliners* (*Flight*, August 5th, pages 202-203), it now transpires there were a number of errors in both the civil and military serial numbers of these aircraft, for which I must accept full responsibility!

Correct civil registration serials of the three P.A.A. Stratoliners should have read NC 19902, 19903, and 19910, whilst those of T.W.A. were NC 19905, 19906, 19907, 19908 and 19909. The tenth and last B-307 built (owned by Howard Hughes) originally bore the civil registration NC 19904 and, although now owned by a Mexican millionaire, is believed to possess the same civil registration because I understand it is still based "somewhere in the U.S.A."!

I should also like to point out the correct wartime U.S.A.A.F. serial numbers allocated to T.W.A.'s five Boeings were not as given but in fact were 42-88623 to 42-88627 inclusive.

In quoting the above information I should like to extend thanks to Mr. J. M. G. Gradidge, B.Sc., who went to a great deal of trouble in carefully checking his own extensive data records on the Stratoliners.

Another error, to which I must plead "not guilty," was the printing of "$285.000"; this should have read "$385,000."

Nairobi, East Africa. DENNIS M. POWELL.

CORRESPONDENCE . . .

Aircraft Noise

IN the daily Press there has lately been a good deal of controversy —though in view of its one-sidedness that is probably the wrong word—on the subject of aircraft noise. While I sympathize with some of the people who are unlucky enough to live directly under the take-off path from military airfields from which jet aircraft operate, I find it less easy to understand complaints (and there have been many) from people residing at a distance of say eight or nine miles from big airports such as L.A.P.

I live in such a situation myself, but I have never yet been worried—much less awakened—by the noise. Thousands of people live beside busy railway lines and do not even notice the sound of trains by day or night, yet aircraft noise (which, distance for distance, is probably much lower in decibel value) always brings these complaints. Is it not perhaps a question of an old generation and a new noise?

Personally, I find the sound—like some railway noises—quite a "friendly" one. So often, especially on the approach before going into fine pitch, engines can be heard idling so gently that anyone of a mechanical turn of mind is made happy at the thought that they probably could go on running like that for weeks or months.

Kingston-on-Thames, Surrey. EARTHBOUND.

FORTHCOMING EVENTS

Oct. 7. Helicopter Association: "The Control of Helicopter Rotor Vibration," by P. R. Payne.
Oct. 10. Institute of Transport: Presidential Address by P. G. Masefield, M.A.(Eng.), F.R.Ae.S., M.Inst.T., F.I.Ae.S.
Oct. 19. R.Ae.S.: Graduates and Students Section: Rocket films.
Oct. 20. R.Ae.S.: Main Lecture: "The Jet Flap," by I. M. Davidson.
Oct. 25. R.Ae.S.: Section Lecture: "Boundary Layer Effects in Supersonic Flow," by R. J. Monaghan.
Oct. 26. British Institution of Radio Engineers: Annual General Meeting and Lecture.
Oct. 27-28. Aircraft Electrical Society: 12th Annual Display of Aircraft Electrical Equipment, Los Angeles.
Oct. 28. R.Ae.S.: Graduates and Students Section: Dance.
Oct. 28. Aerouto Association (Chelsea College Old Students): Dinner and Dance, Ardington Rooms, London, S.W.4.
Nov. 2. Institute of Welding: Annual Dinner, Park Lane Hotel.
Nov. 3-4. I.A.S. and C.A.I.: Second Annual Joint Meeting, Ottawa.
Nov. 11. Helicopter Association: "Design of Helicopter Operating Sites," by H. T. Hough, M.I.C.E., M.I.Mun.E., M.T.P.I.
Dec. 16. London Airport Inauguration by H.M. the Queen.

R.Ae.S. Branch Fixtures (to November 2nd):—
Oct. 12. *Manchester*, "Development of Guided Weapons," by W. H. Stevens. Oct. 17, *Halton*, Film and talk. Oct. 19, *Coventry*, "Cockpit Hoods," by Dr. Holland.
Oct. 20, *Southampton*, "Gas Turbines: Basic Principles and Production Problems," by C. E. Wurr; *Isle of Wight*, "Domain of the Helicopter," by R. Hafner, F.R.Ae.S. Oct. 31, *Halton*, Problems of Space Flight," by F/L. R. W. Durrant. Nov. 2, *Southampton*, "Flight Refuelling," by P. S. McGregor.

THE INDUSTRY

Efficient Factory-construction

BUILDING a factory to a time schedule—even more than building a house—depends on so many imponderables that the contractor who undertakes such a task must have plenty of confidence in his methods. That such confidence was not lacking in the case of the new foundries erected at Nuneaton, Warwickshire, for Sterling Metals, Ltd., was apparent on a recent visit to the site. The contractors were Beecham Buildings, Ltd., and they had guaranteed that they would complete the building within a year. The standing of both firms, is, of course, proof that no question of jerrybuilding would enter into the matter.

The projected foundry was to be no small affair. The main block measures 500ft long by 267ft wide. It consists of a central north-south bay spanning 67ft, flanked on each side by two bays each of 50ft span. All five bays are 28ft high from floor to eaves level. Along the full length of the east side is another bay of 34ft span, with an eaves height of 40ft. The total floor area is some 200,000 sq ft.

That the promise was fulfilled, in spite of a particularly cold and wet winter and spring, is largely due to the method of precast construction employed, a speciality of Beecham Buildings. Without going into building technicalities of a kind that would be out of place in an aviation journal, it may be said very briefly that the reinforced-concrete structural members and the majority of the walling elements were pre-cast in Beecham's works at Shipston-on-Stour, some 30 miles distant, transported by road, then erected at the site by a small, highly-mechanized team.

Advantages claimed for the factory production of concrete members, as opposed to pouring of concrete in shuttering on the site, include the facts that (1) assembly of moulds and reinforcement, and mixing of concrete, can be effected with precision and economy; (2) permanent, rigid moulds ensure good surface finish; and (3) production of members is unaffected by weather.

Though the system is to this extent a standardized one, the range of basic members available is so wide that any Beecham building can be specially designed for the processes it is to house.

Apart from the technical methods employed, there is the additional advantage that the whole of the work—design, quantities, precast production, transport, erection and civil engineering—is in the hands of various departments of a single, closely co-ordinated organization.

One of the bays of the building referred to above: in this photograph it awaits roofing with glass and aluminium sheeting. Along the tops of the main columns are beams to carry rails for five-ton travelling cranes at 18ft above floor level.

Flexible Tubing from A. and P.

THE development of seamless stainless-steel flexible tube was announced recently by Accles and Pollock Ltd., the Oldbury, Birmingham, firm of steel-tube manufacturers. The new product makes its appearance after a considerable period of development work, and following discussions with the principal aircraft companies, which have led to an agreed size range.

The flexible tube is made by producing helical convolutions in thin-walled stainless-steel tube. The plain tube for subsequent manufacture of flexible hose can be made from any of the popular types of austenitic stainless steel; and, after convoluting, the material is in the slightly cold-worked condition. During the convoluting operation the wall thickness is not reduced and the finished length is slightly less than half the original plain tubing, which means that lengths of convoluted tubing are limited to approximately half those for cold drawn seamless tubes.

To assist economic production, state Accles and Pollock, the sizes it is proposed to manufacture are being limited to a representative range decided in consultation with other interested industries. This range will be extended, however, and there is no reasonable limit to the process. The cost of tools for a special size is, however, comparatively high.

The first list gives seven sizes with nominal bores ranging from $\frac{1}{16}$in to $\frac{1}{2}$in. Outside diameters range from 0.320in to 1in in the same range, and wall thicknesses are between 0.006in and .014in.

Tools for the manufacture of these sizes are being produced to a schedule and some of them will not be available until early next year.

Sperry-Canada Contract

RECENTLY announced by the Sperry Gyroscope Company of Canada is a contract for fire-control equipment for the U.S. Air Force, amounting to some $1,300,000 (£470,000). Components are to be manufactured and assembled at the company's Montreal plant (which was purchased from the Canadian Government last April), and delivery is expected to be completed within a year.

Mond Nickel Appointment

THE Mond Nickel Co., Ltd., have appointed Dr. W. Steven, B.Sc., Ph.D., to be superintendent of the development and research laboratory in Birmingham in succession to the late Mr. Howard Evans. Dr. Steven spent five years with William Jessop

Much successful development of these vital weapons is being carried out by Armstrong Whitworth. Other recruits for the forces of the free West coming from Armstrong Whitworth are the N.F. (night fighter); the Sapphire Hunter, "first choice for European defence"; the Sea Hawk, the Royal Navy's latest jet fighter.

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THE INDUSTRY . . .

and Sons, Ltd., and joined the Mond Nickel Company in 1947 as a research metallurgist. In May 1954 he was appointed principal assistant to the superintendent.

Mr. Howard Evans, A.Met., F.I.M., died suddenly on September 11th. He joined the company in 1938, was appointed principal assistant to the superintendent in 1945, and became superintendent in 1954. He was 47 years of age.

Netherlands Minister at English Electric

THE minister of Defence for the Netherlands, Mr. Cornelis Staf, recently visited the works of the English Electric Company's guided weapons division at Luton and Stevenage. Mr. Staf travelled in a Naval Whirlwind helicopter from London to Luton Municipal Airport, where he was received by A. V-M. Sir Conrad Collier, chief executive of the guided weapons division. After touring the company's Luton works, the Minister travelled by car to the new town of Stevenage, where he inspected English Electric's extensive new works. He later returned to London by helicopter, taking off from an area inside the English Electric Works.

Holland's problems in regard to guided-missile defence are, of course, closely comparable with those of Great Britain, both countries having populations of considerable size concentrated in a small land area.

Ground D.C. Supply

NEW equipment for providing a D.C. supply for the ground testing of aircraft instruments and services is announced by the General Electric Co., Ltd. They have designed a naturally air-cooled rectifier unit having an input voltage of 400/440 volts, 50 cycles, three-phase supply, and an output of 26-30 volts at 10 amp D.C. The inherent voltage regulation of the unit is 6 per cent. A six-position transformer rotary tapping switch controls the output voltage.

Input connection is made by a switch and fuse unit at one end and the output connection is made by a shuttered socket and plug at the opposite end, where a control switch, output fuse, and voltmeter are mounted.

The rectifier unit, which can carry an electric camera weighing 60 lb, is mounted on castors and fitted with a pram handle for easy movement. Each of the four castors is fitted with a foot-operated brake. Dimensions of the rectifier are 18in × 24in × 36in.

Exceptional manœuvrability, conferred by a three-wheel chassis, is a feature of the 25-cwt electric vehicles made by Wales and Edwards, Ltd., of Shrewsbury, who are now fulfilling a repeat order for B.O.A.C. Mickleover Transport, Ltd., the London distributors, modify the bodywork to the Corporation's requirements for internal use at L.A.P.

For "Fescolising" Aircraft Parts

WELL known for their "Fescol" electro-deposition process, the firm of Fescol, Ltd (whose head offices are at North Road, London, N.7) have acquired a new factory at Huddersfield. Specially built for them, it was opened by the Mayor of Huddersfield on September 13th. The plant is approximately twice the size of the existing works at Huddersfield which the company has occupied for 14 years.

It was in the older works that Fescol developed a method of applying their process to light alloys. Experimental work was undertaken for an aircraft manufacturer.

After further investigation an improved technique has been developed which, it is stated, enables the company to deposit chromium direct on to all known light alloys so that the deposited material becomes an integral part of the base metal. The new process has received Ministry of Supply approval for use on aluminium and aluminium alloys used in the construction of aircraft and aircraft equipment.

The Fescol process, the company states, differs from any other known commercial methods in that the chromium is deposited directly on to the light alloy and does not rely on an undercoat of a second metal to ensure adhesion.

IN BRIEF

The British Metal Corporation, Ltd., announce that they have been appointed agents for the sale in the British Commonwealth (except Canada) of titanium and titanium alloy semi-manufactures produced by the Titanium Metals Corporation of America.

* * *

Mr. P. G. Fielding, A.F.R.Ae.S., who for three years was technical assistant to the chief designer of Saunders-Roe, Ltd., and more recently special projects engineer, is shortly to join the special projects division of the Lockheed Aircraft Corporation, Marietta, Georgia, U.S.A. Mr. Fielding, who is 36, obtained his workshop training at Dowty Equipment. In 1938 he joined the design staff at Gloster Aircraft Co., Ltd., and remained there until after the war, when he became a member of the experimental design staff of the de Havilland Aircraft Co., Ltd., which he left to join Saunders-Roe in 1947.

Mr. A. E. Underwood has been appointed to the main board of the Plessey Co., Ltd. He joined them in 1948.

Mr. K. W. Watkins, now Hymatic project engineer, will also maintain technical liaison with the industry.

The appointment is announced of Mr. Harry Mundy, A.M.I.Mech.E., M.S.A.E., as technical editor of our associated journal *The Autocar*.

* * *

Flight Refuelling, Inc., of Baltimore, have elected Mr. John H. Sidebottom their vice-president. For the past ten years he has been assistant director of technical service at the Aircraft Industries Association.

* * *

Following the merger of Hordern-Richmond, Ltd., with Permali, Ltd., new Manchester premises for both companies have been opened at 3rd Floor, B Block, 89 Oxford Street, Manchester, 1. The new office is also the northern headquarters of the newly-formed company, Hydulignum-Jabroc (Tools), Ltd.

* * *

Fairey test pilots in the North recently gave a cocktail party at Manchester for friends in the industry, the airlines, the Ministries and the Services "from whom they receive invaluable co-operation in their day-to-day flight-testing of aircraft from the production lines at Heaton Chapel and Ringway." The host was David Masters, senior test pilot at Ringway.

* * *

Pending his retirement at the end of this year, Mr. William Smith has relinquished his duties as managing director of Ferodo, Ltd., but will remain a director until his retirement. Mr. G. S. Sutcliffe (sales director) becomes managing director and Mr. E. R. Pochin (home sales manager) joins the board as home sales director. Mr. M. H. Good takes over the duties of home sales manager and Dr. N. Carpenter those of technical sales manager.

* * *

A recent agreement between Robertson Thain, Ltd., of Ellesmere Port, Frank Segner and Co., Ltd., of Manchester, and Bush, Beach and Gent and Co., Ltd., of London, permits the two latter companies to market grades of Stypol polyester resins which are used for general laminating purposes. Stypol HLT, used in the manufacture of translucent sheeting, and Stypol resins, employed for potting and casting electronic equipment, will still be sold exclusively by Robertson Thain, Ltd.

CIVIL AVIATION

As reported below, the Scottish Aviation Twin Pioneer recently made the first official departure from the new runway at Prestwick. The essential features of this promising 16-seat transport are emphasized in this take-off view.

PRESTWICK'S NEW RUNWAY

PRESTWICK Airport's new runway, 6,000ft in length and capable of extension to 8,000ft, came into operation on September 30th. The first "official" landing was made on it by a M.T.C.A. Dove carrying Sir Alfred Le Maitre, Controller of Ground Services, and A. Cdre. J. G. Murray, Scottish Divisional Controller. The official party was greeted by the airport commandant, Mr. J. Jeffs, who joined them aboard the Twin Pioneer prototype to make the first take-off from the new runway. At present the runway has no approach aids and can be used only in V.F.R. conditions. It is expected to be available for unrestricted use from April 1956. In the past, B.O.A.C. Stratocruisers have sometimes been forced by cross winds to overfly Prestwick, an occurrence which should be eliminated when the runway is in full use.

COMET OFF TO THE TROPICS

COMET 2 G-AMXD flew from Hatfield to Khartoum on September 30th to complete performance measurements in "I.S.A.-plus" temperatures. Although unmodified structurally, this particular Comet 2 is representative of the fully modified aircraft now being completed by de Havilland for R.A.F. Transport Command in the matter of all-up weight (120,000 lb) and engines. These are the Mk 117 version of the Rolls-Royce Avon, of 7,300 lb static thrust each, an increase of 150 lb over the Avon 503 with which initial tropical trials were carried out in February 1954.

The present tests are, of course, a part of the programme for the full-category civil certificate of airworthiness with which the Comet 2 will enter service with the R.A.F. early next year.

The Comet 2 flew from Hatfield to Khartoum, with a stop at Athens: for the record, journey times for the two sectors were respectively 3 hr 26 min and 3 hr 42 min, appropriate average block-to-block cruising speeds being of the order of 440 m.p.h. and 430 m.p.h. The aircraft was flown by Mr. John Cunningham, de Havilland chief test pilot, and Mr. Peter Bugge, with a crew of nine engineers and observers including representatives of Rolls-Royce and the A.R.B. The tests, which include a full programme of take-offs and cruising performance at various weights, were expected to be completed within two weeks.

A HELIPORT FOR HARLOW—

OBVIOUSLY, it is easier to provide a helicopter landing-place in a new town than to construct one in the average existing urban area. Harlow New Town, appreciating this, has "got in on the ground floor" by planning for a heliport from the outset.

At present, the site is close to the town centre and comprises a level grass "L," each arm being 100ft by 150ft with a concrete raft in the centre of each arm. No buildings are yet provided, but office, shelter, cafeteria or other accommodation is envisaged if future development justifies it. During the present (experimental) period, no landing fees are being charged.

On October 5th the Harlow heliport was due to have been formally opened by Marshal of the Royal Air Force Lord Douglas of Kirtleside, who was to have arrived, with Lady Douglas, in a B.E.A. Bristol Sycamore. They were to be met by representatives of Harlow Development Corporation, including Alderman T. H. Joyce, deputy chairman, Dr. Stephen Taylor, Mr. Eric Adams, Mr. Frederick Gibberd (architect planner for Harlow and also architect for London Airport) and Mr. O. W. Gilmour.

—AND FOR WILLESDEN

PRIVATE enterprise has given London its first permanent heliport. The Borough Council of Willesden has granted to Helicopter Services, Ltd., of Gatwick Airport, the concession (initially for a six-month trial period) to operate a municipal heliport on Twyford Tip, the former refuse dump near the North Circular Road, almost opposite Stonebridge Park station (Bakerloo). Twyford Tip stands some 50 to 60ft above the surrounding building development, and is in the centre of a very important industrial region. It is already in use by Helicopter Services, Ltd., for the regular delivery of film material to the nearby B.B.C. television processing laboratories.

The site already has M.T.C.A. approval, and it is understood that a full airfield licence will be applied for. Helicopter Services are expected to establish passenger and maintenance buildings and night-flying facilities.

Helicopter Services, Ltd., the concessionaires, were formed recently by Mr. David Brown and Brig-Gen. A. C. Critchley for private helicopter work. It has a capital of £100,000 and incorporates Rotor Films (London), Ltd., previously operated by Capt. John Crewdson, formerly of B.E.A. and Autair, Ltd., and Capt. T. M. Clutterbuck, both of whom are directors of the new company. Other directors are Mr. A. D. Worton and Mr. J. B. P. Williamson, chartered accountants.

The company has four Agusta-Bell 47 three-seater helicopters, with a further two on order. The company's present operating and maintenance base is Gatwick Airport though it is planned to set up a forward operating base at the Willesden site which will be developed as a public heliport to serve the North West London area.

B.O.A.C.'s WINTER SCHEDULE

ANNOUNCING details of their winter programme, B.O.A.C. say that savings of the greater part of a day on two first-class flights from London to Tokyo will be made when the new time-tables come into force in November. A night-stop at Hong Kong on the eastward-bound flights will be eliminated and, as on most other Eastern routes, transit stops are to be reduced from one hour to 45 min at many places.

Thus, one London-Tokyo service—which calls at Rome, Beirut, Karachi, Calcutta, Bangkok and Hong Kong—will take 45½ hr on the new schedules against 63 hr at present. Similarly, the time of a service which flies the same route—but calls at Zurich instead of at Rome and at Rangoon instead of at Bangkok—will be reduced from 66 hours to 45½ hr.

Latest Viscount off the Hurn production line, and the 74th to be delivered, is YI-ACK, the first of three V.735s for Iraqi Airways.

Cairo will cease to be a stop for B.O.A.C. first-class South African services, which will fly *via* Rome - Khartoum - Nairobi - Livingstone and Johannesburg. South African Airways, B.O.A.C.'s partner on the Springbok route, will continue to serve Cairo.

The nine first-class Stratocruiser flights a week between London and New York, operated during the summer, will be retained but there will be fewer tourist flights. On other Atlantic routes there will be an increase in the number of flights compared with last winter. There will be four first-class and three tourist flights between London and Montreal a week; two first-class and four tourist services a week between Prestwick and New York; and three flights weekly of each class between Prestwick and Montreal.

An extra stop—at Montreal—will be included, subject to Government approval, in the route of the weekly first- and tourist-class Stratocruiser to the Caribbean. The new route will be: London, Montreal, Bermuda, Barbados, Port of Spain.

The number of B.O.A.C. services between New York and the Caribbean will be increased during the winter months. From mid-December a twice-weekly first-class Stratocruiser service between New York and Nassau will be introduced and in January it will become a daily operation.

On November 12th, B.O.A.C. and their Caribbean subsidiary B.W.I.A. will jointly inaugurate twice-weekly Viscount services between New York and Bermuda. These will be first-class services. Tourist flights over the same route will be operated daily by Super Constellations chartered from Seaboard and Western Airlines.

MORE SUPER CONNIE FREIGHTERS

AN order from the Flying Tiger Line for ten L.1049H Super Constellations was announced on September 30th by the Lockheed Aircraft Corporation. The Flying Tigers are the last of America's three major all-freight airlines to buy the model H version of the Super Constellation; orders have already been placed by Slick Airways and by Seaboard and Western Airlines. In addition, it has been ordered for passenger-freight service on the routes of Qantas.

The Flying Tiger contract, valued at £7.2m, calls for delivery of the aircraft in 1957. With a full payload of 42,600 lb, the L.1049H is credited with a cruising speed of 335 m.p.h. and a range of 2,200 miles. Provision is made for fitting up to 109 seats when the aircraft is required for passenger work.

U.S. TRAFFIC TEN YEARS HENCE

"AIR transport's share of the U.S. carrier market will rise from its current 29 per cent to more than 50 per cent by 1965," predicts a study issued by the U.S. Civil Aeronautics Administration. The report, *Civil Air Traffic Forecasts, 1960-1965*, estimates that in 1965 U.S. airlines will carry on international services six million revenue passengers, compared with 2.8 million in 1954. The equivalent domestic total is calculated to be 70 million, more than double the 1954 total. Freight and mail will increase to 800 million ton-miles, three times the 1954 level, mainly due to more economical cargo aircraft and improved equipment. According to the report, U.S. aircraft manufacturers in 1965 will deliver 400 large civil transports valued at $660 million.

BOEING 707 ECONOMICS

SOME new performance estimates for the Boeing 707 are given by Mr. Ralph Bell, Boeing's director of sales, in the current issue of his company's magazine. The civil version of the 707, the Stratoliner, is claimed to have a decided economic advantage over present long-range equipment on both domestic and overseas routes. Its range and speed, Mr. Bell observes, would make possible non-stop services with single rather than double crews, and the working capacity of the aircraft, he claims, is about three and a half times that of a DC-7 or Super Constellation. According to Boeing, "Nine 707s will provide the same seat-miles as 25 DC-7s."

On the trans-continental route between New York and San Francisco, the Stratoliner should be capable of achieving times of five hours eastbound and 5 hr 37 min westbound. According to Boeing's figures, its direct operating costs for the non-stop run would be 27 per cent less than for the DC-7, and even with stops at Denver, Chicago and Cleveland *en route* the jet transport should have a 22 per cent advantage.

A sales point emphasized in the article is that the standard of seating provided by a 103-passenger Stratoliner would be comparable to that in a 60-seat DC-7 or 67-seat Super Constellation.

RUSSIANS TOUR B.E.A. BASE

THE Soviet delegates who came to Britain to study building construction visited the B.E.A. Engineering Base at London Airport on September 24th. The delegation was headed by the Soviet Deputy Prime Minister, Mr. V. A. Kucherenko, who is also Chairman of the State Committee for Construction Affairs, and including Mr. Cushchin, Deputy Minister of Construction. Mr. N. P. Dudorov, Chief Designer of State Committee for Construction Affairs, Mr. I. I. Loveikov, Chief Architect of Moscow, and Professor Gvozdev, Professor of Concrete. Members made a two-hour tour of the hangars and workshops and also inspected the staff canteen, which B.E.A. believe to be one of the most up-to-date in the country.

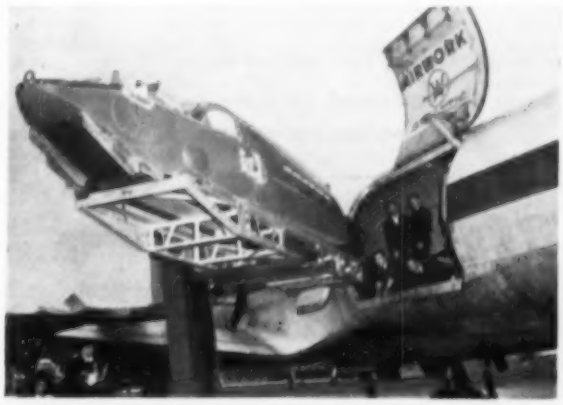
The Soviet delegates were shown round the B.E.A. base by Mr. H. A. Smith, personal assistant to the works manager. Mr. Kucherenko said that the delegation were most interested and impressed by what they saw, but they were amused by the staff's ten-minute break for tea—"We don't have that in Russia," he said.

Capt. John Crowdson, of Helicopter Services, Ltd., is here seen bringing in one of that company's Agusta-Bell helicopters to the Willesden Heliport referred to on p. 598.

A CARRIER'S LIABILITY TO ITS PASSENGER

AN amendment to the 26-year-old Warsaw Convention was signed at The Hague on September 29th by 26 nations. It concerns the presumed liability of an air carrier for a passenger killed or injured on an international flight, and the protocol to amend the Convention to bring it more in line with present-day money values was sponsored by I.C.A.O. Liability is increased to a maximum of U.S. $16,582 (or 250,000 Poincaré gold francs), double the amount at present provided. This liability limit, which also covers air cargo and baggage, does not apply in the case of "wilful misconduct" on the part of the carrier.

The conference lasted three weeks and was attended by 136 air lawyers from 44 countries presided over by Professor D. Goedhuis of the Netherlands. The new rate will come into force when it has been signed by 30 countries.



"Bluebird," Mr. Donald Campbell's record-breaking speedboat, is soon to be used in a new attempt on the record at Lake Mead, Nevada. It is seen going aboard Airwork Atlantic's DC-6A for New York at London Airport last Saturday.

A tapered fin, not unlike that of the Viscount, is shown in this new artist's impression of the Lockheed Electra. The colours are those of Eastern Air Lines, who last week announced an order for 40 of these 66/91-seat turboprop airliners and an option on a further 30.

CIVIL AVIATION . . .

BREVITIES

ACCORDING to a report from Nairobi last week, three of B.O.A.C.'s Argonauts will be made available to East African Airways next spring. They will be used for services to Central and South Africa, Portuguese East Africa and—in collaboration with B.O.A.C.—to London. It is also reported that Britannia services to Johannesburg, due to be inaugurated next April, will be routed *via* Entebbe in wet weather until completion of the new Nairobi Airport at Embakasi.

* * *

Seventeen *ab initio* candidates have been chosen by Lufthansa for training as airline pilots. Pupils will be trained by the German airline's own flying school. The full course of instruction is expected to take between two-and-a-half and three years.

Record transatlantic freight traffic is reported by Pan American for August. During the month the company's aircraft carried 240 tons of cargo between the United States and Europe, 44 per cent more than in August 1954. The company is now operating ten all-freight return services weekly across the North Atlantic.

* * *

In commemoration of the first flight to the Belgian Congo made 30 years ago by a Handley Page Hamilton, Sabena have struck bronze medallions depicting the Congo route. One of the medallions was presented recently to Sir Frederick Handley Page.

* * *

Plans for a seasonal car-ferry service between Ferryfield and Basle are announced by Silver City Airways. The 400-mile route will be flown in two hours 40 min by Superfreighters, each carrying up to three cars and 15 passengers. Services will begin on December 16th and will operate on Fridays, Saturdays and Sundays until March 31st. The new ferry is designed primarily to cater for winter sports travellers.

* * *

An order for three L.1049G Super Constellations is announced by Air-India International Ltd. The first aircraft, for delivery in May 1956, was bought as a replacement for the Constellation 749 *Kashmir Princess*, lost last April in the South China Seas as a result of sabotage. The two remaining aircraft will follow in 1957.

MORE ABOUT THE FRYE F-1

MORE information is now available on the Frye F-1 project for a DC-3 replacement, first details of which were given in *Flight* for September 23rd. The model illustrated in that issue was based on a design study which has now been superseded, and the accompanying illustrations show the project at its latest stage.

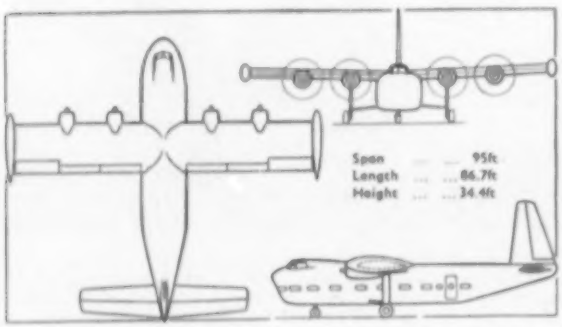
The company responsible for the F-1, the Frye Corporation, was formed about six months ago in Fort Worth, Texas, by Mr. Jack Frye, a former president of T.W.A. His associates include Mr. Kurt Weil, designer of the Ju 52; Capt. D. W. Tomlinson, a former vice-president, engineering, for T.W.A. and deputy commander of the Berlin air lift; and Mr. G. W. Vaughn, a former president of the Curtiss Wright Corporation. The company intends to concentrate on engineering and development of the F-1, but has no plans for producing it. Negotiations are reported to be in progress with manufacturers in North America and in two European countries. The possibility of production in Latin America has also been mentioned.

Design of the F-1 is not yet completely finalized. It is stated that three manufacturers are evolving undercarriage designs on a competitive basis. Wind-tunnel tests are being conducted at the University of Wichita to determine the optimum nose configuration.

Construction of a prototype is due to begin next year. It is intended to equip the prototype and, possibly, first production aircraft with four 600 h.p. P. and W. Wasp piston engines. Eventually, however, these might be replaced by four 850 h.p. turboprops, of a type not yet specified, which will increase the cruising speed by 20 m.p.h. and reduce the take-off distance by perhaps 100 yd.

Simplicity of production, assembly and maintenance have been emphasized in the design of the F-1. All major structures are stated to have been designed to operate without replacement for 50,000 flying hours and 15 years. Approximate price is quoted as $350,000 (£125,000).

An artist's impression of the Frye project (Wasp-powered version).



The Frye Corporation is reported to have received inquiries from several short-haul airlines, including five American local service operators. The first order is expected to be placed by a Far Eastern airline. According to our contemporary, *Aviation Week*, the sponsors of the F-1 stress that it is not intended to be competitive with the "more sophisticated" Handley Page Herald. Mr. Frye is quoted as saying: "In fact, we have told some potential customers that they would be better off if they took a look at the Herald, because we feel it will suit them better than the F-1."

Span, length and height of the F-1 are included in the three-view drawing (left). Other data are as follows:— Wing area, 1,350 sq ft; cargo-door loading height, 4ft 4in; nose cargo-door dimensions, 7ft × 11ft; side cargo-door dimensions, 7ft × 7ft; normal gross weight, 30,000 lb; wing loading, 22 lb/sq ft; passenger capacity, 50 to 70; interior dimensions, 40ft × 10ft × 6.5ft; max speed, 170 m.p.h.; cruising speed, 150 m.p.h.; minimum speed, 55 m.p.h.; take-off distance to 50ft (whether with one engine inoperative is not stated), 900ft. These figures apply to the piston-engined version with four 600 h.p. Pratt and Whitney S1H1-G Wasps.

Soon to take up new appointments (see below) are (left to right) Air Marshal Sir George Mills, Air Marshal Sir Harry Broadhurst and A.V-M. the Earl of Bandon. Air Chief Marshal Sir Basil Embry (right) is retiring.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

HIGH COMMAND CHANGES

CONSIDERABLE changes in the higher command structure of the Royal Air Force have now been officially announced. The principal result of these re-appointments is that a number of senior officers will be retired during the next year, making way for the promotion of officers who in the main had operational flying experience in World War 2. There is, however, no firm indication that the promotions have been made solely with this factor in mind. For the first time, also, the Chief of the Air Staff is likely to be a graduate of Cranwell. Hitherto C.A.S.s had served in one of the other Services during World War 1 before joining the R.A.F.

Appointments already made public—the names were announced last week—are the following:—

Air Marshal Sir George Mills, now A.O.C-in-C. Bomber Command, is to succeed Air Chief Marshal Sir Basil Embry as Commander Allied Air Forces Central Europe. He will hold the acting rank of air chief marshal. Sir Basil is to be retired from the Service.

Air Marshal Sir Harry Broadhurst is to be A.O.C-in-C. Bomber Command. He will be succeeded as C-in-C. 2nd T.A.F., Germany, by A.V-M. the Earl of Bandon, who will assume the acting rank of air marshal. This appointment carries with it the NATO command of 2nd T.A.F.

A.V-M. R. B. Jordan, with the acting rank of air marshal, is to become A.O.C-in-C. Maintenance Command in place of Air Marshal Sir Gordon Harvey, who is retiring.

A.V-M. R. L. R. Atcherley, with the acting rank of air marshal, is to be A.O.C-in-C. Flying Training Command in place of Air Marshal Sir Lawrence Pendred, who has retired.

A.V-M. G. E. Nicholetts is to be A.O.C. Malta, assuming the acting rank of air marshal, in place of Air Marshal Sir Bryan Reynolds, whose next appointment will be announced later. A.V-M. Nicholetts' appointment carries with it the NATO post of Air Deputy to the Commander-in-Chief Allied Forces Mediterranean.

In addition, A.V-M. G. D. Harvey will become A.C.A.S. (Training) and A.V-M. A. D. Selway will command the R.A.F. Staff, British Joint Services Mission, in Washington. A.V-M. Selway was until recently air attaché in Paris.

All these appointments will take effect toward the end of this year, or in January 1956. It was earlier announced that Air Chief Marshal Sir William Dickson, the present C.A.S., would continue in this position for an extra year until January 1957. It is reported that he will then be succeeded as C.A.S. by Air Marshal Sir Dermot Boyle, the present A.O.C-in-C. Fighter Command.

Exercise "Sea Enterprise"

THE carrier task force exercise in Norwegian waters ended on Wednesday of last week, the actions being considered to have produced satisfactory exercise for the forces engaged. Bad weather, though it hindered some operations, gave ships and aircraft good experience of operating under those conditions.

A wide variety of aircraft was engaged, including Coastal Command Neptunes, Shackletons and Sunderlands, carrier-borne Sea Hawks and Wyverns and a helicopter anti-submarine squadron of the Fleet Air Arm.

A force of surface raiders was spotted and shadowed by aircraft and a force of Blue (friendly) ships sent to engage it. Orange (enemy) submarines were also active and claimed to have attacked successfully one of the carriers and a cruiser. Shore-based aircraft made an "effective" attack on one of the carriers just as she was recovering her aircraft soon after dawn.

One of the main operations during "Sea Enterprise" was the replenishment exercise, when the carriers refuelled and took on stores from supply ships to the south of the battle area. These were escorted by the Canadian carrier *Magnificent*. Bad weather here delayed proceedings to some extent.

A number of strikes were made against targets on the Norwegian mainland by carrier aircraft, which were intercepted by Norwegian F-84s and Sea Hawks from Lossiemouth, temporarily based with them.

Two surface raiders, H.M.S. *Apollo* and *Decoy*, were first spotted near Trondjem by a AD-3W Skyraider from a carrier and subsequently shadowed by shore-based Shackletons.

A number of other NATO sea/air exer-

Also involved in the recently announced command changes are (left to right) A.V-M. R. B. Jordan, A.V-M. R. L. R. Atcherley, A.V-M. G. E. Nicholetts and A.V-M. A. D. Selway.

SERVICE AVIATION . . .

cises were taking place in various phases in other sea areas, particularly in the Atlantic. One, called "Centre Board," was to last nine days and provide an opportunity for close co-operation between British, American, French and Portuguese forces. Another exercise, called "Tide Rip," involved the redeployment of the Dutch Air Force's No. 320 Sqn., with Neptunes, to Topcliffe, and of a French Naval Lancaster squadron to St. Mawgan. Operations were carried out despite extremely poor weather.

These exercises have been controlled by Admiral Sir Michael Denny, C-in-C. Eastern Atlantic Area and Air Chief Marshal Sir John Boothman, Air C-in-C. Eastern Atlantic Area, from their H.Q. at Northwood.

Air Marshals in Jets

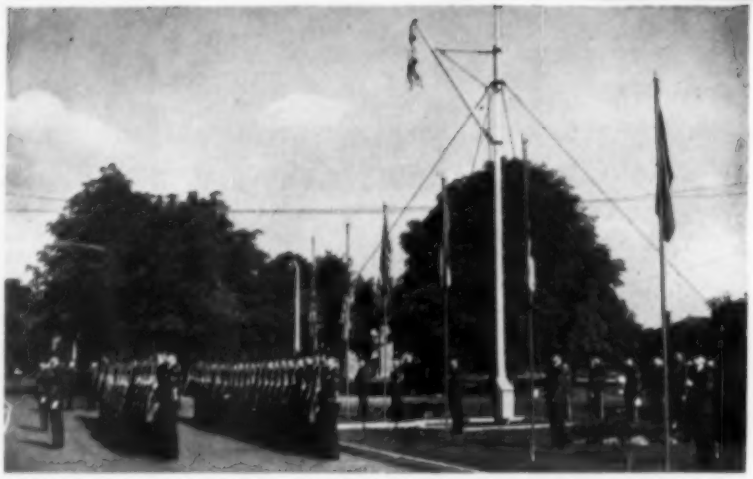
THE A.O.C. No. 1 Group, Bomber Command, A.V-M. J. R. Whitley, can claim to be the first air vice-marshal to have flown himself across the North Atlantic in a jet aircraft. He led the team of No. 139 (Jamaica) Sqn's. Canberras on their recent visit to the Caribbean area. Air Marshal Sir Dermot Boyle, his predecessor in this post, can claim a similar distinction for the crossing of the South Atlantic when he led a Canberra team visiting South America in 1952.

Carriers for the Far East

THE light fleet carriers *Albion* and *Centaur* are to go to the Far East Station next year for tactical exercises with the Far East Fleet and with Australian and New Zealand naval forces. They will leave England in the New Year and return early in May.

Jet Provost Evaluation

A TRAINING flight at Hullavington has now been equipped with pre-production Jet Provosts and a batch of pupils is being trained to fly entirely on jet aircraft. Service evaluation of the aircraft has already been completed at C.F.S., South Cerney, and instructors were converted there ready for the beginning of the course. After an initial period on Jet Provosts the pupils will go on to the normal Vampire Trainer F.T.S. course. No conclusions on this first trial have yet been published.



The flags of the competing nations being unfurled at Uxbridge as the R.A.F., U.S.A.F., French, Belgian, Dutch and Norwegian teams competing for the Britannia Shield were welcomed by Air Chief Marshal Sir William Dickson last weekend.

Reunions

THE second reunion dinner of No. 92 (East India) Sqn. will be held at the Eccleston Hotel, London, on October 15th. Details from P. C. Forster, 8 Elder Avenue, Crouch End, London, N.8.

Nos. 50 and 61 Sqns. will hold their reunion at the Cock Inn, Fleet Street, London, on October 29th, at 6.0 p.m. Tickets, price 10s, from J. Lascelles, 15 Crantock Road, Catford, London, S.E.6.

Nos. 7 and 14 R.N.A.S., and R.A.F. Handley Page Sqns. Association A.G.M. and annual dinner will take place on October 29th. Details from G. Conley, 62 Nightingale Lane, London, S.W.12.

The annual dinner of the R.A.F. (Middle East) 1914-1923 Dinner Club will be held at the R.A.F. Club, Piccadilly, London, W.1, on November 10th. Details from A. W. Carroll, Langley, Saffron Walden, Essex.

The sixth reunion of R.A.F. and F.A.A. personnel who served at the U.S. Naval Air Station, Pensacola, Florida, during the war will be held at the Feathers Hotel, Westminster, London, on November 26th. Details from L. V. Armstrong, 47 Rutland Road, Wanstead, London, E.11.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments announced by the Air Ministry:—

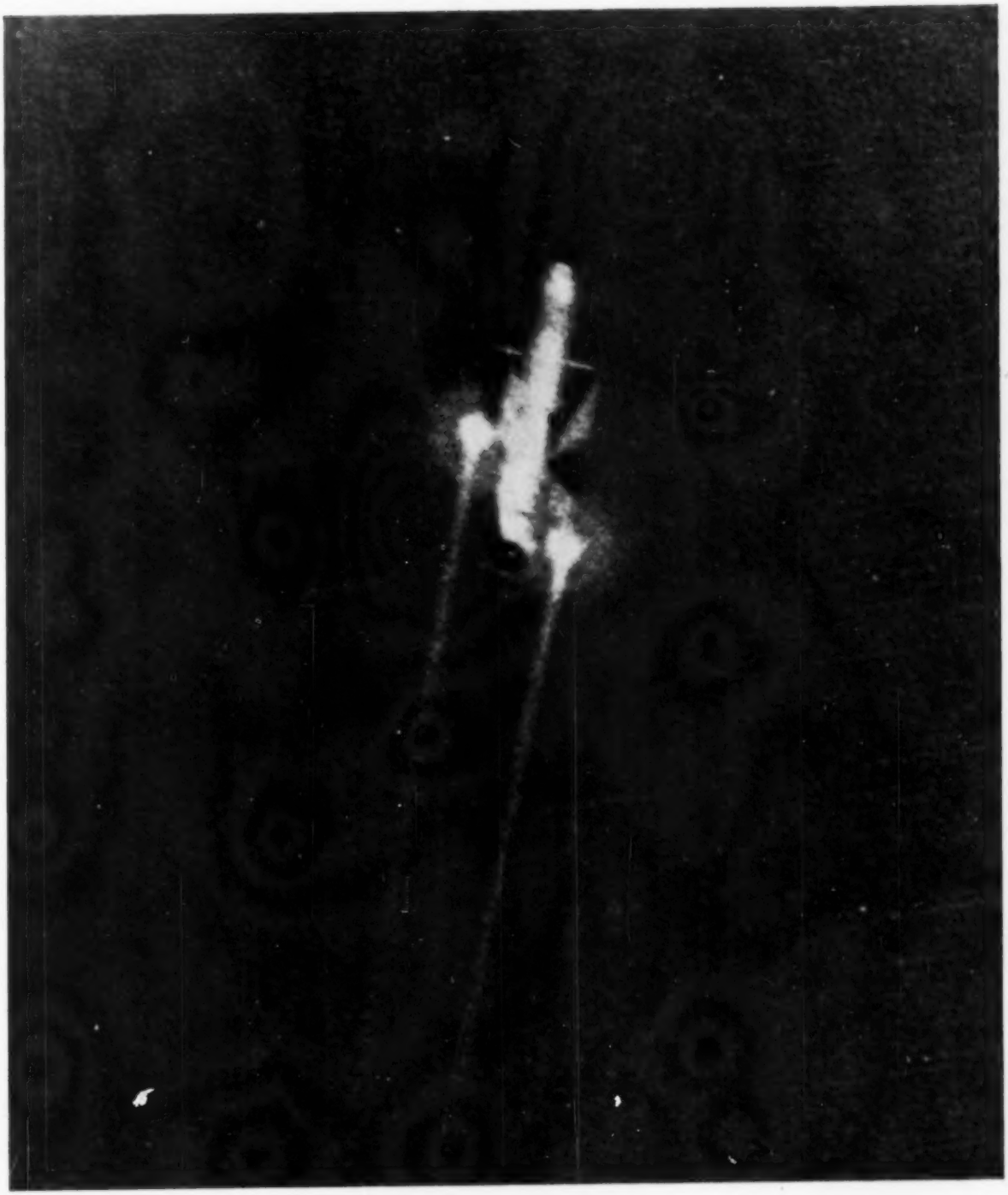
G/C. W. E. Coles, C.B.E., D.S.O., D.F.C., A.F.C., to H.Q. Flying Training Command for air staff duties; G/C. C. F. S. Fraser to the Ministry of Supply; G/C. W. J. Macken, O.B.E., to the Ministry of Supply; G/C. E. J. Rae to H.Q. Middle East Air Force for air staff duties; G/C. T. I. Iliff to R.A.F. Honington to command; G/C. M. C. R. White to H.Q. Fighter Command for administrative duties.

W/C. E. Q. Moody to R.A.F. Habbaniya, Iraq, for administrative duties; W/C. R. J. Tilley to Air Ministry for duty in the Department of the Air Member for Supply and Organization; W/C. A. F. Wallace, O.B.E., D.F.C., to H.Q., Flying Training Command, for air staff duties; W/C. G. Young to Air Ministry for duty in the Department of the Chief of the Air Staff; W/C. S. E. C. Walker, D.S.O., to H.Q., Home Command, for administrative staff duties; W/C. P. R. Godby to R.A.F. Topcliffe for flying duties.

W/C. D. F. Beardon, A.F.C., to R.A.F. Leuchars to command (acting rank of group captain); W/C. C. C. M. Baker, O.B.E., to R.A.F. Aberporth to command; W/C. J. Brain, A.F.C., to R.A.F. Linton-on-Ouse for administrative duties; W/C. P. Griffiths, O.B.E., to H.Q. Technical Training Command for administrative staff duties; W/C. A. S. Judson, D.F.C., to the Joint Services Staff College for directing staff duties.

S/L. J. R. Burges to M.o.S. (acting rank of wing commander); S/L. F. W. Morgan, M.B.E., to M.o.S. (acting rank of wing commander); S/L. I. G. Broom, D.S.O., D.F.C., to the R.A.F. Flying College, Manby, for tutorial staff duties (acting rank of wing commander); S/L. E. I. Elliott to No. 5 (L.A.A.) Wing, R.A.F. Regiment, to command (acting rank of wing commander); S/L. R. E. W. Harland to M.o.S. (acting rank of wing commander); S/L. R. W. Jeary to Air Ministry for duty in Department of the Chief of the Air Staff (acting rank of wing commander); S/L. J. D. de S. McElwain to Air Ministry for duty in the Department of the Air Member for Supply and Organization (acting rank of wing commander); S/L. H. J. Knevitt to Air Ministry for duty in the Department of the Air Member for Supply and Organization (acting rank of wing commander); S/L. H. E. White, D.F.C., A.F.C., to R.A.F. Leeming for flying duties (acting rank of wing commander).

The crew of one of the Javelins which flew from Coltishall in Exercise "Beware." They are W/C. E. D. Crew, pilot, and S/L. J. Walton, radar operator.



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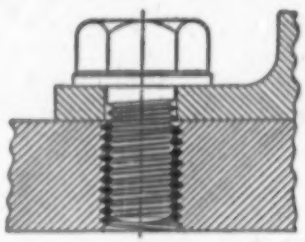

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APPLICATION forms and further information from the Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting number S 128/55. [4301

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PATENTS

THE proprietor of British Patent No. 674489 relating to Lifting Rotors for Aircraft offers same for licence or otherwise to ensure practical working in Great Britain. Enquiries to Frank B. Dehn and Co., 103 Kingsway, London, W.C.2. [4298

PUBLIC ANNOUNCEMENTS

AIR TRANSPORT ADVISORY COUNCIL

THE Air Transport Advisory Council give notice that they have received the undermentioned applications to operate scheduled air services:

FROM Don Everall Aviation, Ltd., of Elmdon Airport, Birmingham, 26, for the following Seasonal Inclusive Tour Services to be operated with Dakota aircraft in conjunction with Transglobe, Ltd., for the carriage of passengers for a period of seven years:

APPLICATION No. 631. For a service between Birmingham (Elmdon) and Basle (Mulhouse) at a frequency of one return flight weekly to be operated on Fridays during the season from June to August inclusive each year, from 1st June, 1956.

APPLICATION No. 632. For a service between Birmingham (Elmdon) and Perpignan at a frequency of one return flight weekly to be operated on Sundays during the season from the first Sunday in May to the third Sunday in September inclusive each year, from 6th May, 1956.

APPLICATION No. 633. For a service between Birmingham (Elmdon) and Palma with intermediate traffic stops at Lyons (Bron) and Barcelona, at a frequency of one return flight weekly to be operated on Sundays during the season from the first Sunday in May to the third Sunday in September inclusive each year, from 6th May, 1956.

APPLICATION No. 634. For a service between Birmingham (Elmdon) and Munich at a frequency of one return flight fortnightly to be operated on Mondays during the season from the first Monday in June to the second Monday in September inclusive each year, from 4th June, 1956.

APPLICATION No. 635. For a service between Birmingham (Elmdon) and Venice at a frequency of one return flight fortnightly to be operated on Tuesdays during the season from May to September inclusive each year, from 7th May, 1956.

APPLICATION No. 636. From B.K.S. Air Transport, Ltd., of 1, Marylebone High Street, London, W.1, for a Seasonal Inclusive Tour Service to be operated with Dakota and Viking aircraft in conjunction with R. W. McBean for the carriage of passengers and supplementary freight between Leeds (Yeadon) and Amsterdam at a frequency of three return flights weekly, operated on Wednesdays, Fridays and Sundays, during the season from April to October inclusive each year for a period of seven years, commencing 1st May, 1956.

FROM Eagle Aviation, Ltd., of 29, Clarges Street, London, W.1, for the following Seasonal Inclusive Tour Services to be operated with Viking aircraft for the carriage of passengers and supplementary freight for a period of seven years, commencing 1st May, 1956:

APPLICATION No. 637. For a service in conjunction with Co-operative Travel Service (C.W.S., Ltd.) between London (Blackbushe) and Turin (Caselle) at a frequency of four return flights weekly during the season from May to October inclusive each year, to be operated Saturdays, Sundays and mid-week.

APPLICATION No. 638. For a service in conjunction with Co-operative Travel Service (C.W.S., Ltd.) between London (Blackbushe) and Basle at a frequency of four return flights weekly during the season from May to September inclusive each year, to be operated Saturdays or Sundays and mid-week.

APPLICATION No. 639. For a service in conjunction with See Spain, Ltd., between London (Blackbushe) and Venice (Treviso) at a frequency of one return flight weekly during the season from May to October inclusive each year, to be operated on Mondays.

APPLICATION No. 640. For a service in conjunction with See Spain, Ltd., between London (Blackbushe) and San Sebastian at a frequency of one return flight weekly during the season from May to October inclusive each year, to be operated on Saturdays or Sundays.

APPLICATION No. 645. For a service in conjunction with Sir Henry Lunn, Ltd. between London (Blackbushe) and Turin (Caselle) at a frequency of four return flights per week to be operated on Saturdays, Sundays and mid-week during the season from May to October inclusive each year.

FROM Dan-Air Services, Ltd., of Bilbao House, 36/38 New Broad Street, London, E.C.2, for the following Seasonal Inclusive Tour Services to be operated with Dakota aircraft for the carriage of passengers and supplementary freight for a period of seven years:

APPLICATION No. 641. For a service in conjunction with Lissone Lindeman (London), Ltd. between London (Blackbushe) and Cologne at a frequency of up to six return flights weekly during the season December to March inclusive each year, commencing December, 1955, to be operated on Fridays, Saturdays and/or Sundays.

(Continued at top of column 2, page 27)

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Candidates should apply in the first instance to the

Chief Designer

PUBLIC ANNOUNCEMENTS

(*Continued from column 2, page 26*)

APPLICATION No. 642. For a service in conjunction with Colussus (Jersey), Ltd., between Southampton (Eastleigh) and Jersey at a frequency of six return flights weekly during the season May to September inclusive each year, commencing May, 1956, to be operated from Fridays to Mondays inclusive.

APPLICATION No. 643. For a service in conjunction with Colussus (Jersey), Ltd., between London (Blackbushe) and Jersey at a frequency of nine return flights weekly during the season May to September inclusive each year, commencing May, 1956, to be operated from Friday to Monday inclusive.

APPLICATION No. 644. From Derby Aviation, Ltd., of Derby Airport, Burnaston, near Derby, for a Seasonal Inclusive Tour Service to be operated with Dakota aircraft in conjunction with Midland Travel Agents Associated for the carriage of passengers between Derby and Palma (Son Bonet), with intermediate traffic stops at Nottingham and Birmingham, at a frequency of two to four return flights weekly, operated on Friday to Monday inclusive, during the season from May to October inclusive each year for a period of seven years, commencing May, 1956.

APPLICATION No. 84/1. From Hunting-Clan Air Transport, Ltd., of 72 Wigmore Street, London, W.1, for an amendment to the terms of approval of the Colonial Coach Service which the Company are approved to operate with Viking aircraft between London and Nairobi at a frequency of one return flight weekly for the period up to 20th February, 1960, so as to operate two additional return flights monthly.

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3 Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained.

WHEN an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [4316

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SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through the local office of the Ministry of Labour and National Service, etc., if the applicant is a man aged 18-64 or a woman aged 18-59 inclusive, unless he or she or the employer is excepted from the provisions of The Notification of Vacancies Order 1952.

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An important Company, engaged in the design and development of major guided weapon projects, require a Senior Mechanical Engineer to take charge of a team concerned with the ground equipment, packaging and power supply unit aspect of this work.

Applicants should have a university degree in mechanical engineering, and considerable experience in the design of mechanical equipment. Some knowledge of solid propellents and explosives would be an advantage.

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A Project Leader is required by an important Company, engaged in the design and development of major guided weapon projects, to lead a team of engineers engaged in the development of mechanical aspects of guided weapons and associated equipment.

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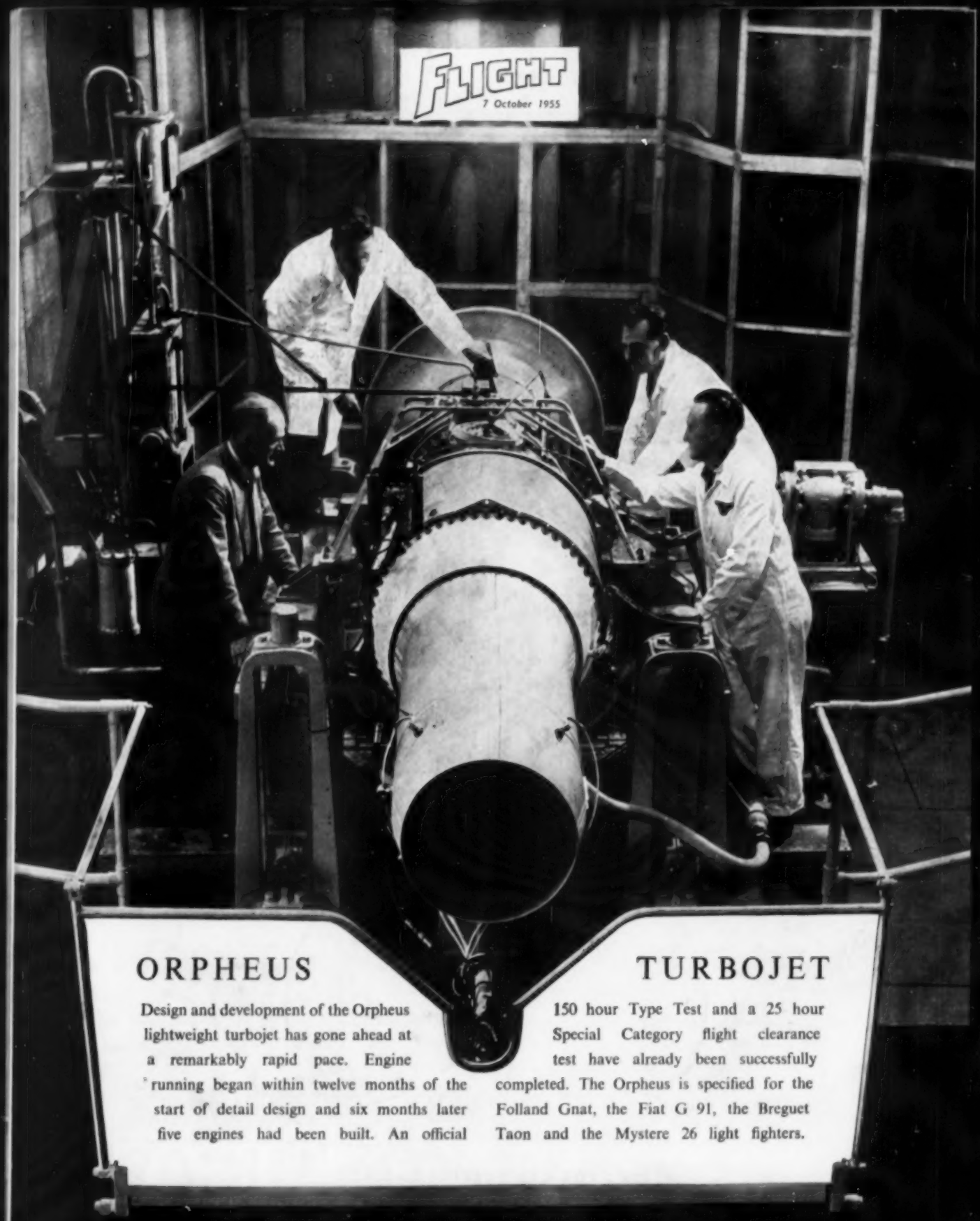

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